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ABSTRACT

This monograph includes the following articles to aid in implementation of fitness concepts: (1) "Trends in Physical Fitness: A Personal Perspective" (H. Harrison Clarke); (2) "A Total Health-Fitness Life-Style" (Steven N. Blair); (3) "Objectives for the Nation--Physical Fitness and Exercise" (Jack H. Wilmore); (4) "A New Physical Fitness Test" (Steven N. Blair, Harold B. Falls, and Russell R. Pate); (5) "Health Related Physical Fitness" (Russell R. Pate); (6) "Distance Running Performance Tests in Children--What Do They Mean?" (Kirk J. Cureton); (7) "Measurement of Body Composition in Children" (T.G. Lohman); (8) "Flexibility--A Major Component of Physical Fitness" (Charles B. Corbin and Larry Noble); (9) "Medical Problems Encountered by Women in Aerobic Exercise" (Dorothy V. Harris); (10) "Psychological Benefits of Aerobic Exercise" (Dorothy V. Harris); (11) "Physiological Responses of Females to Endurance Exercise" (Harold B. Falls); (12) "How Much Exercise Is Enough?" (Michael L. Pollock); (13) "Teaching Physical Fitness Concepts in Public Schools" (Russell R. Pate); (14) "Teaching Health-Related Fitness in the Secondary Schools" (Charles B. Corbin); (15) "The Hope-Kellogg Health Dynamics Program" (Richard A. Peterson); (16) "The Aerobics Program at Oral Roberts University" (Paul Brynteson); (17) "Helping Adults To Stay Physically Fit--Preventing Relapse Following Aerobic Exercise Training" (G. Ken Goodrick, Don R. Warren, G. Harley Hartung, and Jean A. Hoepfel); (18) "A Corporate Health and Fitness Program--Motivation and Management by Computers" (William B. Baun and Michelle Baun); (19) "Physical Fitness--Programming Issues for Total Well Being" (Kenneth H. Cooper and Thomas R. Collingwood); (20) "Incorporation of Aerobic Exercise into Health Maintenance Programs of Business and Industry" (Dennis Colacino); and (21) "Prevention of Orthopedic Injuries Related to Aerobic (Jogging) Exercise" (David E. Cundiff). Articles include references, tables, figures, and photographs. (JD)

Implementation of Health Fitness Exercise Programs

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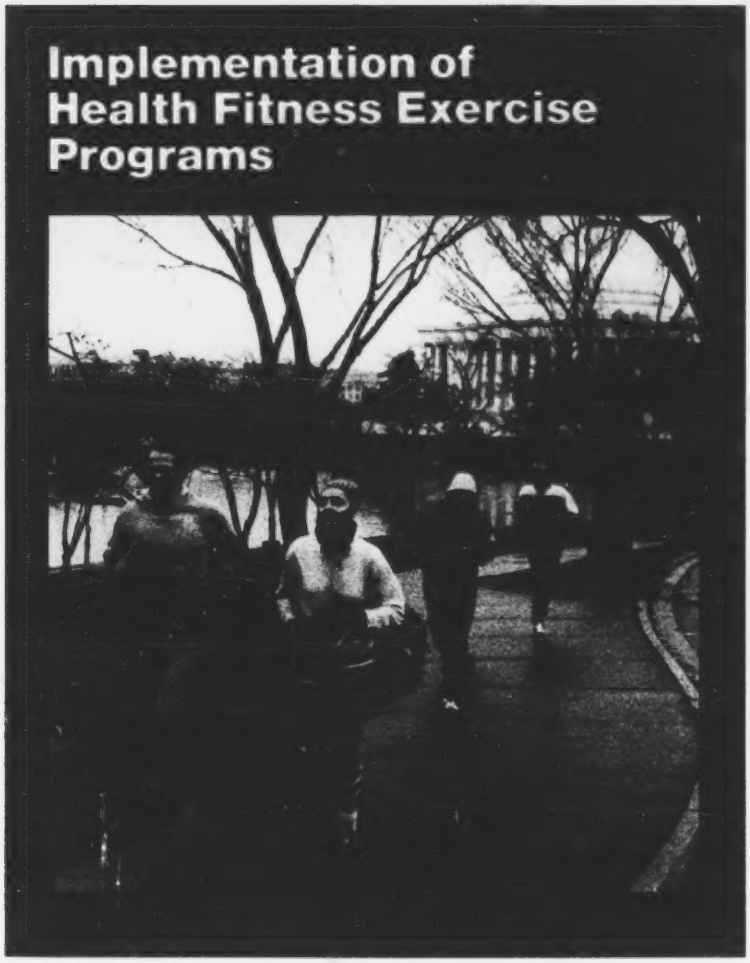

David E. Cundiff
Editor

Credits

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PURPOSES OF THE AMERICAN ALLIANCE FOR HEALTH, PHYSICAL EDUCATION, RECREATION AND DANCE

The American Alliance is an educational organization, structured for the purposes of supporting, encouraging, and providing assistance to member groups and their personnel throughout the nation as they seek to initiate, develop, and conduct programs in health, leisure, and movement-related activities for the enrichment of human life.

Alliance objectives include:

1. Professional growth and development—to support, encourage, and provide guidance in the development and conduct of programs in health, leisure, and movement-related activities which are based on the needs, interests, and inherent capacities of the individual in today's society.
2. Communication—to facilitate public and professional understanding and appreciation of the importance and value of health, leisure, and movement-related activities as they contribute toward human well-being.
3. Research—to encourage and facilitate research which will enrich the depth and scope of health, leisure, and movement-related activities; and to disseminate the findings to the profession and other interested and concerned publics.
4. Standards and guidelines—to further the continuous development and evaluation of standards within the profession for personnel and programs in health, leisure, and movement-related activities.
5. Public affairs—to coordinate and administer a planned program of professional, public, and governmental relations that will improve education in areas of health, leisure, and movement-related activities.
6. To conduct such other activities as shall be approved by the Board of Governors and the Alliance Assembly, provided that the Alliance shall not engage in any activity which would be inconsistent with the status of an educational and charitable organization as defined in Section 501(c)(3) of the Internal Revenue Code of 1954 or any successor provision thereto, and none of the said purposes shall at any time be deemed or construed to be purposes other than the public benefit purposes and objectives consistent with such educational and charitable status.

Bylaws, Article III

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Preface

Some of the articles in this book were presented at a national conference in 1976 on "Aerobic Exercise: Scientific Basis and Implementation of Programs" which was cosponsored by the Physical Fitness Council of the Association for Research and Professional Councils and Societies and Oral Roberts University. This resulted in the first edition, *Implementation of Aerobic Programs,* published by the American Alliance for Health, Physical Education, Recreation and Dance, in 1979.

The success of the first edition gave impetus to this second edition. Since the Health Related Physical Fitness Test is being used more widely, it was felt that this edition should be expanded to include information for professionals interested in implementing Health Related Fitness Programs in public schools, colleges and universities, and business and industry. Papers have been added on body composition and musculoskeletal function that were published in the *Journal of Health, Physical Education, Recreation and Dance* over the last few years. A special feature is the article by H. Harrison Clarke, "Trends in Physical Fitness: A Personal Perspective." His insight will be of value to many future professionals in this field.

This volume provides articles divided into four general sections:

Section I: Historical Overview of Physical Fitness and Future Objectives
Section II: Definition of Health Related Physical Fitness
Section III: Scientific Basis of Health Related Fitness
Section IV: Implementation of Health Related Fitness Programs

We hope this volume will be of value to those who desire assistance in implementing the Alliance's health related fitness concept in their programs.

David E. Cundiff, Ph.D.
Editor

Historical Overview of Physical Fitness and Future Objectives

Trends in Physical Fitness: A Personal Perspective

H. Harrison Clarke

My professional interest and concern for physical fitness began with my acceptance of a physical education and coaching position in the Chautauqua, New York, public schools upon my graduation from Springfield College in 1925. It was during my Chautauqua tenure that Frederick Rand Rogers, Director of the Health and Physical Education Division in the New York State Education Department, introduced his Physical Fitness Index Test and follow-up program into the schools of the state. It seemed to me then, a belief that became stronger as the years went by, that this test measured two of the basic components of physical fitness, muscular strength and muscular endurance, and that a program designed to help physically subpar boys and girls should be a primary concern of physical educators.

The perspective presented here is not an historical report per se; no attempt was made to locate and evalute historical sources systematically. Rather, it is an observational report of one professional physical educator with a life-long involvement with physical fitness, one who has observed first hand occurrences, trends, and influences pertaining to this field for over a half-century. Conceivably, this account does have historical significance, although it may show bias as reflected in the author's experiences and the influences peculiarly exerted upon him and is restricted to his limited observations, primarily in schools and colleges.

Antedating 1925

Physical education in the United States had its origins in physical fitness. Generally speaking, it was the only objective of physical education prior to World War I, although some transition to other objectives was evident in the early 1900s. Observations to support this assumption follow.

1. The first school and college gymnasia were opened in 1825 at the Round Hill School, Northampton, Massachusetts, and in 1826 at Harvard University. The apparatus, activities, and methods were transplants from the Jahn system of gymnastics in Germany. This system aimed primarily at the development of the physical organism.

2. Another transplant from European physical education was the Swedish, or Ling, system of "medical gymnastics." While first utilized by physicians around 1850, this system was accepted and practiced by physical educators late in the 19th century. Therapeutic exercise and calisthenics evolved from this system, utilized to improve and condition the musculature of the body.

3. Between the Civil War and World War I, most of the physical education leaders were trained in medicine. These men and women physicians were attracted to physical education (physical training as it was known at that time) because of the potential health values of appropriate physical activity properly applied — a form of preventive medicine. However, although the care and development of the body was a primary concern, they also recognized that physical education could contribute dynamically to the individual's mental, emotional, and social effectiveness.

As we well know, the tragic lesson of World War I, when a large proportion of our youth were found physically unfit for military service in defense of the nation, resulted in a tremendous expansion of physical education in educational institutions throughout the United States. Prior to this time, only three states had state laws requiring physical education in their schools. By 1932, thirty-six states, representing ninety percent of the population, had such a law. Also, colleges and universities throughout the country established similar requirements.

Between World Wars

This period of rapid expansion brought significant changes to physical education in the United States. Medical leadership waned and was eventually supplanted by leaders and teachers primarily prepared in pedagogy, psychology, and the biological sciences. In increasing numbers, men and women who could teach, evaluate, and administer physical education graduated from colleges and universities. Graduate programs with attendant research were established, with the first Ph.D. awarded to a physical educator in 1925. Physical education and athletic facilities were established extensively throughout the country.

And, of special significance for this report, a consistent effort was made to align physical education with total school purposes. In so doing, a reevaluation of objectives occurred, as physical educators studied ways by which they could contribute uniquely to the growth and development of children and to their education for lifetime living. Thus, multiple objectives were proposed for this field. Although variously stated, three objectives were recognized: physical fitness, social efficiency, and recreational competency. Methods, materials, and procedures were developed to realize these objectives based on physiological, psychological, and sociological principles.

H. Harrison Clarke is professor emeritus at the University of Oregon, Eugene, OR. *This article was first presented at the Physical Fitness Council meeting, April 14, 1981, AAHPERD Convention, Boston, Massachusetts.*

However, tragically, in the rush to espouse new objectives, physical education generally abandoned its biological heritage. The understandings and tested procedures developed over a century were largely rejected in the rush to adopt new ideas and procedures. Too frequently, the improvement and maintenance of physical fitness became a concomitant of an activity program designed to realize other objectives. The expression "education through the physical" became prevalent, when it should have been "education *of* and *through*" the physical. Data were and still are lacking that physical fitness can be developed systematically and effectively under such circumstances. Contrarily, considerable experiential and scientific evidence exists indicating that the activity program and procedures designed to realize this objective must be specifically planned and carried out.

There were, of course, exceptions to this dismal picture of physical fitness programs in schools and colleges between the world wars; some realistic physical educators developed programs to meet the physical, psychological, emotional, and social needs of individual boys and girls. Excellent texts on corrective and remedial physical education appeared during this time, written by physical educators, as were books on kinesiology and physiology of exercise. Early texts on measurement appeared that included procedures for the evaluation of physical fitness components. Numerous relevant researchs were completed by the newly emerging scientific community in physical education. Consistent recognition of the place of remedial physical education was evident in the structure of the American Association for Health, Physical Education and Recreation, now known as the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD). This national association and several of the district organizations formed therapeutic sections. Physical education programs for handicapped students were commonplace in colleges and universities, especially at the larger institutions.

In speaking of the AAHPERD structure as related in some way to physical fitness, although out of chronological sequence, the Physical Fitness Council, then known as Fitness Section, originated in 1957 with a petition submitted by fifty-six physical educators from around the country. In accordance with association operating procedures for forming new sections, the board of directors approved a tentative section and authorized providing a program at the next annual convention; this arrangement was continued for two years, after which the section was officially recognized by the association. The first program for the section was held in 1958 at the Kansas City convention. There were two meetings: "Basic Components of Physical Fitness" and "Essential Program Procedures for the Development of Fitness." The distinguished speakers at these meetings were: C.H. McCloy, Arthur A. Steinhaus, Henry J. Montoye, Laurence E. Morehouse, Mabel Lee, Marjorie Phillips, Ellis H. Champlin, Karl W. Bookwalter, Donald K. Mathews, Margaret S. Poley, and Joseph B. Wolffe. These sessions were exceptionally well attended; the estimates were 500 at the first and 400 at the second.

During and Following World War II

Physical educators were utilized in important capacities pertaining to the physical fitness programs of the armed forces during World War II. Such physical educators as Charles H. McCloy, Arthur A. Esslinger, Leonard A. Larson, Clifford L. Brownell, Elmer D. Mitchell, and Theodore P. Banks served as consultants, wrote physical training manuals, constructed motor fitness tests, and served as commissioned officers directing physical training programs. Arthur A. Esslinger and Arthur S. Daniels headed physical reconditioning programs in army and army air force hospitals, respectively.

Time does not permit a chronicling of the extensive involvement of physical educators in the war effort. Suffice it to say, this involvement included army, navy, and army/air force physical training programs, the physical reconditioning programs in hospitals and convalescent centers of these same services, and the preflight training programs of the army and navy and the Army Specialized Training Program at many colleges and universities throughout the country. President Franklin Delano Roosevelt called on physical educators in schools and colleges to provide vigorous physical fitness programs for all boys and girls as a vital contribution to the war effort, although he appointed a nonphysical educator (a former famous oarsman) to direct that effort. Other embarrassing appointments from a professional viewpoint were former world heavyweight boxing champions to head the navy and coast guard physical training programs.

Corrective exercise has a long history in physical education going back well over a century. Therapeutic applications of exercise were developed between the wars, not only in physical education but in medicine. Following World War II, the application of physical and motor activities in physical and mental therapy reached an all-time high in Veterans Administration hospitals, especially in the treatment of severely handicapped and chronically ill patients. Many of the practitioners were former physical reconditioning personnel in the armed services. Many civilian hospitals and rehabilitation centers adopted similar programs. The corrective therapists involved founded a professional organization, now known as the American Corrective Therapy Association, which, since 1948, has published a bimonthly magazine, the *American Corrective Therapy Journal.*

In 1968, AAHPERD established a headquarters unit on programs for the handicapped. Julian U. Stein was appointed as a full-time consultant. This unit provided a consultative service, a leadership preparation program, program interpretation, and research. In 1972, an Information and Research Utilization Center in Physical Education and Recreation for the Handicapped was established. The purpose of this center was to collect, categorize, interpret, and disseminate information about materials, methods, ongoing programs, promising practices, research, and demonstrations in adapted physical education and therapeutic recreation. In 1975, an *Annotated Bibliography in Physical Education, Recreation, and Psychomotor Function of Mentally Retarded Persons* was published.

President's Council on Physical Fitness and Sports (9)

As can be seen from the German and Swedish transplants mentioned earlier, an essential motivation of European systems of physical education in the 19th century was preparation for war. European nations have been bounded by potentially powerful enemies, so vigorous physical activity to maintain a strong and enduring citizenry has been vital to them. In the United States, preparation for defense has not been a concern of physical education, *except* during periods of armed conflict, since great oceans have been effective barriers to invasion by major powers elsewhere in the world. Today,

however, this situation has changed. No longer is our geographical isolation an effective deterrent to attack; with the development of aviation and transcontinental missiles, all countries have become neighbors. (7)

Thus, when President Dwight D. Eisenhower formed his Council on Youth Fitness twenty-five years ago, it is quite understandable that his concern for a physically fit nation stemmed from his knowledge, as general of the armies, of the inadequate fitness for military service of too many young men. However, he also treated with respect and concern the findings by Hans Kraus showing that the United States children had many more failures than did Italian, Austrian, and Swiss children on his tests of "minimum muscular fitness." (15) In his executive order forming the council, President Eisenhower stated, "Since the youth of our Nation is one of its greatest assets, it is imperative that the future of our youth be improved and promoted to the greatest extent possible." As is well known, this council in some form has been continued by all subsequent presidents.

Over the quarter century history of the council, various presidential physical fitness consultants were appointed. All but one of these consultants served on a part-time basis; some relied on an administrative assistant to prepare and implement council plans. These appointments were: Chayne McCarthy, by President Eisenhower; Charles "Bud" Wilkinson by President Kennedy; Stan Musial, with Robert Stewart as assistant, by President Johnson; James A. Lovell, with John P. Wilbern as assistant, also by President Johnson; James A. Lovell, Jerry Apadoca, and Al McGuire, with C. Carson Conrad as a newly designated executive director, by Presidents Nixon, Ford, Carter, and Reagan. Conrad, a council consultant since 1961, was formerly state director of health, physical education, and sports in California. The council staff has consistently been a small one, about four professional and unusually effective physical educators, some of whom have continued through several administrations, including Glenn Swengros, Simon A. McNeely, Theodore Forbes, James Winthers, Robert Stewart, William L. Haskell, Richard O. Keeler, A.E. "Ash" Hayes, and Matthew Guidry. In the public relations area, the council has been unusually well served by Richard Snider, V.L. Nicholson, and Kaye Buchanan.

A strong public relations program has been a consistent feature of the council throughout its existence. Starting with Wilkinson's tenure, it began to exert a national influence on the nature and content of physical fitness programs in schools and colleges, youth-serving agencies, community recreation centers, business and industry, and the adult population at large. An enumeration of council projects include: publication of pamphlets and brochures, preparation of instructional and motivational films, establishment of pilot programs and demonstration centers, conduct of regional physical fitness clinics, establishment of Presidential Physical Fitness Awards for Youth and Presidential Sports Awards for adults, publication of a quarterly *Physical Fitness/Sports Medicine* bibliography in collaboration with the National Library of Medicine and of *Physical Fitness Research Digest*, the formation of the American Association of Fitness Directors in Business and Industry, and conduction of medical symposia in conjunction with the American Medical Association, the American Heart Association, and other medical groups.

Governor's councils on physical fitness and sports have been formed in 28 states and many more are in prospect; a National Association of Governor's Councils has recently been established. Two White House sponsored meetings were recently held in Washington: one on physical fitness and sports for all and the other on physical fitness and sports medicine. And, the council has gone international: under Conrad's leadership in collaboration with Jurgen Palm of West Germany, biannual International Conferences on Physical Fitness and Sports for all have been held beginning in 1973; only nations that have government agencies devoted to physical fitness are eligible for membership; at the 1979 meeting in Portugal, thirty-six countries were represented.

Consistently throughout its existence, the council has cooperated with physical education and health-related associations. For example, AAHPERD has responsibility for administering the Presidential Physical Fitness Awards program; the American Medical Association, the Department of Health and Human Services, and the Defense Department were associated in conducting a White House Symposium on Physical Fitness and Sports Medicine. Private enterprise has contributed greatly by financing and promoting films, publications, and special projects.

The impact of the President's Council on Physical fitness and Sports on the physical fitness of youth and adults has been tremendous; never before have so few individuals contributed so dynamically. This effort has not gone unrecognized. Citations were made to the council by AAHPERD in 1972 and by the American Academy of Physical Education in 1975. His Majesty, King Carl Gustaf XVI of Sweden bestowed the Royal Order of the North Star, First Class, upon C. Carson Conrad. Honors have also been bestowed on Glenn Swengros by the Association of Fitness Directors in Business and Industry and on Richard Keeler by the U.S. Attorney General, Griffin Bell, in behalf of the Justice's Department of Occupational Health and Physical Fitness Program. Matthew Guidry recently received the JC Penney Annual Community Service Award.

Low Strength Program

At the start of this address, it was indicated that my professional involvement in physical fitness began in the public schools at Chautauqua, New York, with use of Rogers' Physical Fitness Index (PFI), in order to identify boys who were muscularly weak and to apply appropriate follow-up procedures for their improvement. The PFI is a test of relative muscular strength and muscular endurance. It is derived from a Strength Index (SI), which is a gross measure of dynamometric strengths and arm/shoulder endurance; the SI is related to norms based on sex, age, and weight. Thus, in understanding this program, it is essential to recognize that the primary concern is for those who are muscularly underdeveloped relatively, rather than totally strong.

Generally speaking, the follow-up procedures for low PFI boys and girls consist of: applying muscular strength and muscular endurance activities, while not neglecting circulatory-respiratory endurance; conducting case studies of those who do not improve on periodic retests in order to discover the cause or causes of their continuing unfit condition; referring to other specialists, classroom teachers, and parents when physical defects, organic lesions, nutritional disturbances, or personality maladjustments are found or suspected as a result of the case study process; providing health advice, relaxation procedures, guidance and activities to enhance social and personal adjustment, and medical treatment when indicated in individual cases; and retesting the subfit group at intervals of approximately six weeks and redirecting individual programs in light of retest and restudy results. (11)

This approach to meeting the individual physical fitness needs of boys and girls was developed by physical educators through use in schools and colleges, so it is not just theoretical or imaginative. Further, several extensive demonstration projects have been conducted by public schools in cooperation with nearby colleges or universities. Typically, university professionals assisted in planning the program and in providing physical education major students for administering the PFI test. Local adaptations were made in consultation with school physical educators, administrators, physicians, nurses, counselors, and health education specialists. Among formal projects were:

Central New York State Project (18): For four years, nine public schools participated in cooperation with Syracuse University and the New York State Bureau of Physical Education.

Springfield College Projects (2, p. 328): For several years, Springfield College sponsored projects in schools in New Britain, Connecticut, and in Holyoke and Longmeadow, Massachusetts.

Oregon Pilot Physical Fitness Project (6): During one school year, eleven high schools throughout Oregon cooperated in a pilot project developed by a committee of the state's Association for Health, Physical Education and Recreation; testers were from the Univerity of Oregon and Southern Oregon College.

Moses Lake Project (16): Moses Lake Junior High School, Washington, participated in a project developed by a Washington State Fitness Committee composed of representatives from tne Washington Association for Health, Physical Education and Recreation, the State Department of Public Health, and the State Department of Public Instruction; testers were from Washington State University.

Project Broadfront (3): This project was conducted for five years in the Ellensburg, Washington, public schools. As part of a much broader project, PFI tests were administered semiannually and the low fitness program was conducted; cooperating institutions were Stanford University, University of Oregon, and Central Washington College. The American Academy of Physical Education cited Lloyd Rowley for his administration of Project Broadfront and the Ellensburg School District for its support.

Time and again, the effectiveness of this program to improve the condition of boys and girls who are muscularly weak for their sex, age, and weight has proven effective in actual school situations. When properly applied, it has contributed significantly to the totality of the individual, physically, mentally, psychologically, and emotionally. Muscular strength, both gross (SI) and relative (PFI), is related intricately to the entire physical/motor complex of the individual, including his or her maturity, physique type, body size, motor fitness, and athletic prowess. (4, 8)

At this point, may I inject a tribute to the late Frederick Rand Rogers whose contributions to physical fitness processes through physical education have not enjoyed the recognition they deserve. He was the originator of the Physical Fitness Index; it was his insight, energy, and drive that initiated and promoted PFI programs, first in New York State, then in New England and other parts of the country. Despite all sorts of obstacles and disappointments, he continued to fight for the basic principles and practices of this program. For his prime time in physical education, he had by far the most realistic concept of muscular strength and its fundamental relationships to body, mind, and spirit.

Thomas K. Cureton, Jr.

Several physical educators over the years have made highly significant contributions to physical fitness concepts, processes, and programs. One such person who has been preeminent is Thomas K. Cureton. Starting at Springfield College in 1930, and continuing since 1941 at the University of Illinois, Dr. Cureton has been and still is a teacher, researcher, author, lecturer, consultant, and clinician. He has served school-age youth, university students, and adults. In 1944, he established the Physical Fitness Research Laboratory at Illinois, a laboratory that produced some 600 graduate theses and is still operating. Seventy persons received Doctor of Philosophy degrees as his advisees (14); many on this list are now among our outstanding physical fitness leaders and scientists, an occurrence that has indirectly expanded his influence many fold. Highlights of his significant contributions are briefly mentioned. (13)

1. In the 1930s, Cureton did considerable research and published books, monographs, and articles on aquatics and the improvement of physical fitness through aquatics. During World War II, he conducted aquatics training programs at various U.S. army, navy, marine, and coast guard bases. From 1941–1963, he chaired the AAHPER Aquatics Leadership Committee; about 600 aquatic fitness clinics were sponsored throughout the country by this committee. He worked extensively in the YMCA's of the country on their aquatics and fitness programs.

2. The summer University of Illinois Sports Fitness School for boys was started by Cureton in 1948 and has continued to the present. It has been a model for physical educators at other universities desiring to conduct similar programs.

3. Cureton's extensive studies of adult physical fitness started in 1944. Numerous publications resulted, including five books. His *Physical Fitness and Dynamic Health* appeared on the 100 best-book list of the American Library Association and was a Book-of-the-Month Club selection.

4. Cureton has conducted numerous clinics in YMCA's and universities for many years. For over a decade, he was a regular lecturer and clinician for the six regional clinics sponsored each year by the President's Council on Physical Fitness and Sports. He has served in a similar capacity for physicians, dentists, police, and industrial concerns. He has spread his gospel abroad, lecturing and demonstrating in Germany, Belgium, Canada, Venezuela, and other countries.

5. The publications by Cureton have been enormous: 56 books and monographs and 340 of his articles between 1930 and 1969 are listed in *Education and Fitness — 1969* (14). He is now serving as over-all editor for the four-volume encyclopedia of physical education, fitness and sports, and has shared editorship on single volumes. An early contribution to fitness testing was his *Physical Fitness Appraisal and Guidance*, 1947. He developed the now well recognized system of progressive, rhythmical, nonstop exercise.

6. The honors bestowed on Cureton have been numerous. He has received the AAHPERD's highest award, the Luther Halsey Gulick Medal, and the Hetherington Award by the American Academy of Physical Education. He has been cited by the President's Council on Physical Fitness and Sports, the American College of Sports Medicine, the National YMCA, and the American Dental Association. He has received honorary Doctor of Science degrees from the University of Ottawa and Southern Illinois University.

7. And, believe it or not, Cureton still not only exercises vigorously on a regular basis, but he competes. Just one

illustration: At the 1979 Senior Olympics, he entered 11 events in swimming, running, and bicycling and won them all; his wife Portia, entered six events and won five.

During the past 50 years, Cureton has realistically and dynamically put the "physical" back into physical education.

The Current Physical Fitness Scene in the United States

Indications of Growth

A National Adult Physical Fitness Survey (5) was conducted seven years ago by the Opinion Research Corporation, Princeton, New Jersey. Of this sample of 3,875 men and women, 55 percent indicated that they engaged regularly in some form of exercise. For those who exercised, the main reason was for good health. Adults who participated in physical education when they were in school were more likely to exercise as adults. More than ninety percent of the adults believed that all people should have physical education from elementary school through college.

C. Carson Conrad (12) made a status report on physical fitness today at the 1979 White House Symposium on Physical Fitness and Sports Medicine, in which he gave some startling facts, including: (a) fitness trails were built in more than 1,000 cities during the 1970s, (b) there are nearly two million permanent, or in ground, swimming pools in the United States, 114,300 of which were constructed last year, (c) there are 3,000 commercial health spas and figure salons with three million members, which grossed $400 million in membership fees last year, (d) private enterprises are spending an estimated $5 billion a year on employee fitness programs, and the American Association of Fitness Directors in Business and Industry has more than 1,750 corporate and individual members, (e) sales of sporting goods and related equipment and clothing approached $15.4 billion in 1979, a six-fold increase over 1960, (f) approximately 18 million boys and girls took the National Youth Fitness Test last year, (g) nearly 30 million young people aged 6–12 years of age are involved in out-of-school sports programs.

In his address, Conrad did sound a pessimistic note, despite all the great progress in physical fitness during the past two decades. One concern was that school physical education has not kept pace with national growth in participation; it appears to be in a state of decline with requirements, staffing, and financing being reduced. Of greatest concern in this regard is the tendency of states to eliminate the physical education requirement, placing it on an elective basis in some or all grades, in spite of the fact that parents in a national poll overwhelmingly favored the requirement.

The Jogging-Running Phenomenon

According to a statement by the President's Council on Physical Fitness and Sports (10), the number of runners throughout the United States has doubled in the past five years; it is a present-day phenomenon of considerable proportion. This phenomenon has taken two directions: jogging for cardiovascular fitness and competitive distance running.

Just a few years ago, an article on physical fitness or some aspect of it, such as jogging was a rarity in the press or in popular magazines. Now they are commonplace, thus reflecting a new and continuing interest by the public. The weekly magazine, *Newsweek,* has put joggers on its cover, as did *Sports Illustrated* for the 1980 New York City marathon; *U.S. News and World Report* has written about "The Fitness Mania." Some periodicals are now devoted to running, including *Runner's World, The Jogger, The Runner, On the Run,* and *Marathoner.* Some 30 books on running and exercise for the lay public have been published recently. Famous among these is *The Complete Book of Running* by James F. Fixx, which has sold well over a half million copies, and it was on *Time's* ten best-seller list of nonfiction books for several months. Also, associations devoted to jogging have been formed, such as the National Jogging Association, the American Medical Joggers Association, and the Road Runners of America.

An outgrowth of the jogging phenomenon that has swept the country is competitive distance running. A national calendar of running events throughout the country, appearing in the September 1978 issue of *The Jogger,* although incomplete, listed 88 "Fun Runs" in 35 states and 161 road races in 36 states. For many years, the Boston Marathon was the only one around. Now, marathons are being held in many places, as well as runs of lesser distances. And, competitors number in the thousands. There is also the master's competition and Senior Olympics with categories of runners from middle to old age. Also, women are now competing in distance runs, including marathons. According to one source (1), 50,000 Americans have completed at least one marathon and 4,000 of them have done it under three hours. According to a story by Kenny Moore in *Sports Illustrated* (17), 14,000 men, women, and children ran in the 1980 New York City marathon; 20,000 applicants were rejected. Of the participants 1,142 were lawyers and 546 were physicians; 2,000 were foreign entries from 43 countries; 2,500 volunteers readied 450,000 drinking cups and used 130 gallons of blue paint to put down the line for the course through the five borroughs of New York City.

One might well ask whether the current accelerated participation in jogging and in competitive distance running is a fad or a trend. Jogging for health, should certainly be a trend, since research has demonstrated its essential values for cardiovascular fitness, weight control, and physical fitness generally. All the ballyhoo on distance and marathon running should not obscure or negate these vital values; the need is ever present in a sedentary society. As for competitive distance running, it could be a fad but does not need to be. These long competitive runs may be likened to our interscholastic and intercollegiate athletic programs, an outlet for superior performers (runners in this case) to express themselves fully. Proper jogging regimens are undeniably valuable to the individual, but whether they *must* be increased in duration and intensity to competitive long-distance running is questionable.

It should be realized, however, that, despite jogging's value, other activities, such as swimming, bicycling, rope skipping, hiking, and some sports, also, are effective in developing and maintaining cardiovascular fitness. Further, we must constantly recognize that components, especially muscular strength and muscular endurance, are basic to physical fitness and must not be neglected, especially for those who are physically underdeveloped.

Physical Fitness Research

Although research has been an important endeavor of physical educators for well over a century, the transition mentioned earlier from medical to educational leadership resulted in research primarily becoming a function of graduate education after World War I, which was also in its initial stage in the United States. Very few physical education research

laboratories existed prior to World War II, the most noted of which were at Springfield College, State University of Iowa, and George Williams College; such laboratories were starting at the University of Illinois and University of California at Berkeley. At AAHPERD, the research section was recognized in 1928 and the research council was proposed in 1942; the *Research Quarterly* originated in 1930.

Following World War II, the increase in research laboratories was dramatic, so that presently many graduate departments of physical education have well established and equipped laboratories with well prepared and experienced professors in charge. Interdisciplinary research has become prevalent. From the standpoint of physical fitness research, one manifestation of this was the formation of the American College of Sports Medicine in 1954; in this organization, physical education scientists are associated with physicians and exercise physiologists in a common research endeavor that has become increasingly productive.

Physical fitness research, most certainly, has not been confined to physical education. In recent years, several other disciplines have contributed greatly, although in some instances physical education scientists have been jointly involved. Some of these are: epidemiologists, who have contrasted the incidence of degenerative diseases among physically active and physically sedentary populations; nutritionists, who have shown that exercise is an effective partner to proper diet in fat reduction; cardiologists, who have shown the need for exercise in the prevention of and rehabilitation from heart attacks; physicians, who have recognized the desirability of early ambulation and exercise following major surgery; exercise physiologists, who have found that exercise favorably affects blood pressure, resting and exercising heart rates and concentrations of cholesterol and triglyceride in the blood stream; physiatrists who showed the extreme deleterious effects of confined bed rest upon the total organism; psychiatrists who demonstrated the value of exercise in the treatment of mental and emotional disorders; and gerontologists, who established the value of proper exercise in slowing physiological aspects associated with the aging process. Also, in business and industry, studies have shown the value of physical fitness in reducing absenteeism, in improving workers' effectiveness, and in prolonging working careers of employees and executives. Physical educators have shown the totality of man, physically, mentally, psychologically, and socially; and they have studied the nature, extent, and significance of physical differences between individuals.

Speaking of physicians, a great change in the attitude of the medical profession toward exercise has occurred: twenty-five years ago, most "could care less"; today, medical associations and leaders are strong advocates of the proper kind and amount of exercise as a health-promotion means. Some physicians, such as Hans Kraus, Kenneth Cooper, Samuel Fox, and George Sheehan, are well known in this field.

All aspects of relevant research constitute an essential part of the present physical fitness scene. The research results of many aspects of physical fitness have been widely disseminated in the professional literature and in media presentations for the lay public. These results are convincing proof that the proper kind and amount of exercise are essential for an effective life-style for all Americans. They constitute the basic justification and motivation for exercise as a way of life.

In Conclusion

We saw physical fitness as the only objective of physical education in the early days of physical education; its value was associated with preparation for defense and with preventive medicine while other values of exercise were realized concurrently. Then, we saw physical fitness wane in imporance, to become concomitant to other objectives of physical education. Finally, we saw a resurgence in emphasis on physical fitness triggered and promoted by presidents of the United States through their physical fitness councils and dynamically supported by research from many sources that demonstrated its value for the total well-being and effectiveness of the individual. We are now riding a crest that should continue to mount ever higher as more and more Americans realize the importance of exercise as a way of life and incorporate it appropriately into their everyday life-styles.

In schools and colleges, physical educators need to stress the importance of physical fitness and should mount and maintain effective daily programs with emphasis on those who are deficient in basic physical fitness components. At the same time, physical educators should remember that physical education has other essential purposes in the preparation of boys and girls for living that should not be neglected.

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A Total Health-Fitness Life-Style

Steven N. Blair

Our human ancestors have been on this planet for perhaps 2 million years. For 99.5 percent of that time they existed as hunters and gatherers. The development of agriculture began some 10,000 years ago; we have had cities for about 8,000 years, and our dependence on fossil fuel came about only within the past few hundred years. Today's modern technological society with nuclear energy and computers has developed within our short lifetimes. The life-style of modern Americans is so different from that of our hunting and gathering ancestors that we can scarcely comprehend it.

Few hunting and gathering societies are left, but those still extant can tell us something about how our ancestors lived. The bushmen of the Kalahari have been studied and provide some insight into those earlier life-styles.[1] Although their lives are difficult by our standards, particularly during the dry season, they appear to be healthy and happy. The major tasks, of course, are concerned with obtaining food and water. Shelter in their mild climate is not a problem. Clothing needs are few and simple (the fashion houses of Paris and New York are unknown and there is apparently no planned obsolescence). There is no mass advertising to create artificial needs for worthless products and no department stores for purchasing them, therefore their material possessions are few.

The hunting and gathering tasks are somewhat physically demanding, although not overly arduous. The duration, frequency, and intensity of this enforced exercise prescription is apparently adequate to maintain a lean body and appropriate levels of physical fitness.

The bushmen appear to have ample time and inclination for singing, dancing, and storytelling as leisure activities. They also spend considerable time resting in the shade in camp. By and large they appear to have a simple yet pleasant life. This is possible even though they have been pushed into one of the most inhospitable geographical areas of the globe. It is easy to imagine that the earlier hunters and gatherers, who had access to the lush savannas and semitropical areas full of game and vegetation, had an even more enjoyable existence.

It is occasionally fun to ask philosophical questions and let the mind play with answers. We frequently hear the term "quality of life." What does it mean? How can quality of life be defined? What is optimal quality of life? Are we really any better off than our hunting and gathering ancestors in terms of quality of life? Civilization has brought many advances for humankind, but there are also negative developments. The high technology that provides us with modern creature comforts has also provided the means to destroy the planet. It matters little whether this occurs suddenly in nuclear holocaust or by degrees in the form of resource depletion and pollution. The bushmen seem rather happy and well-adjusted; is our quality of life superior? Civilization has produced art, music, and literature for uplifting human spirit and intellect. It has also produced feminine-hygiene spray, dozens of plastic kitchen or home appliances advertised on late night TV, and a materialistic society that cries more, more.

My conclusion is that man's technology has outstripped his evolution. We simply are not meant to live as we do in highly developed, technological overkill that exists in the industrialized world. Of course, we cannot all suddenly become hunters and gatherers, nor do I advocate a destruction of civilization and a return to those simpler times. What I am suggesting, however, is that many of our current problems, and I will focus on health matters, can best be understood when interpreted in the perspective of historical anthropology. Perhaps some life-style changes can be made that will simplify our lives, improve our health, and at the same time permit continued enjoyment of the high culture produced by several thousand years of civilization.

Life-Style, Health Problems, and Health Status

Most of us learned some commonsense health rules from our parents, grandparents, and doting aunts and uncles. Don't eat between meals. Breakfast is the most important meal of the day. Smoking will stunt your growth. Don't get fat, and so on *ad nauseum*. As we became educated we began to doubt these statements as lacking scientific proof and dismissed them as old wives' tales. Now it appears that those concerned relatives and friends were right after all, and we can support those concepts with evidence.

Recent research from all three avenues of medical research (clinical, epidemiological, and experimental) implicate many health habits as etiological factors in a wide variety of major disease problems.

Cigarette smoking probably causes more morbidity and excess mortality each year than any other single health habit. This one habit has been convincingly implicated as a contributing cause to chronic lung disease, various types of cancer (especially lung), coronary heart disease (CHD), and other circulatory ailments. Literally hundreds of studies on smoking and health are

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published annually around the world, and summaries of this research are readily available.[2,3]

A second major health behavior specifically linked to various ailments is the broad category of diet. The eating pattern is admittedly one of the two major components to energy balance (the other being physical activity) and as such, a contributor to obesity. Obesity has been recognized as a major public health problem in the United States[4,5,6,7] and a contributor to various diseases.[8,9,10]

The eating pattern is also thought by many to be related to CHD. Research over the last two or three decades has shown that the high-calorie, high-fat, and high-cholesterol diet of Americans causes high levels of blood lipids, especially cholesterol. These lipid abnormalities are definitely related to the development of atherosclerosis, the major cause of heart attack and stroke.[11,12,13] These findings meet the criteria for determining causal relationships between risk factors and disease.[11] It is important that controlled experimental studies now provide us with reasonable explanations of pathogenetic mechanisms to support the earlier epidemiological and clinical findings.[14]

The American diet is also perhaps related to certain cancers. The second-leading cause of cancer mortality is colorectal cancer,[15] for which diet has been suggested as a cause.[16,17,18,19] Diet has also been tentatively linked to cancer of the stomach, breast, and uterus.[19]

A third major life-style component related to health is physical activity. Sedentary living produces low levels of physical fitness or physical work capacity (PWC).[20] Work physiologists frequently express PWC in METS. One MET equals the amount of energy expended in a resting state, 10 METS refers to an energy expenditure of 10 times resting. Sedentary adult Americans typically have a PWC of 7-9 METS.[21] Since sustained work capacity for 12-16 hours is probably limited to 15-20 percent of PWC,[22] the average sedentary person can average only 1.5-2.0 METS over the course of a day without fatigue. Trained persons not only have a higher PWC, they can use a greater fraction of it over long time periods. Thus, it seems reasonable to conclude that many sedentary persons are so unfit that it limits their ability to enjoy life. Numerous worldwide epidemiological studies have shown that more active groups tend to have less CHD.[23,24,25,26] Although these studies tended to have methodological flaws,[25,27] and additional work needs to be done, it appears that it is better to be active than sedentary.[23]

Regular physical activity has also been linked with a reduction in obesity,[28,29] prevention of low-back pain,[20] as an antidote for "stress,"[31,32] and "feeling better."[33]

Other life-style components can obviously affect health and well-being. Violent deaths due to accidents and homicides are a major problem.[34] Although many of the causes are difficult to identify, it is evident that lack of safety consciousness (failure to wear seat belts, for example) or drug abuse (especially alcohol) are prime candidates.

It is also difficult to ascertain how many Americans succumb to ennui or are "just in a rut." They drift through life without fully experiencing "joie de vivre." The causes of these symptoms are probably impossible to identify, but it is safe to say that persons in that condition are certainly not functioning at top social and emotional health. Are there life-style components related to these problems? Perhaps. Perhaps not. But it would be interesting to see if the symptoms would disappear if the other more tangible health behaviors discussed previously were practiced.

Several reports on the relationships between health practices and health status have been published by the California Human Population Laboratory.[35,36,37,38] More than 6,000 persons randomly selected from Alameda County (Oakland), California, were surveyed for health status (physical, mental, and social) and health practices. They were followed for 5 years to determine mortality rates. Summary findings from these studies indicate a definite relationship between health practices and longevity. Seven significant health practices were identified: (1) eating breakfast, (2) eating regularly with no snacks, (3) eating in moderation, (4) smoking abstinence, (5) moderation in alcohol consumption (if drinking at all), (6) engaging in regular physical exercise, and (7) regularly sleeping 7-8 hours a night. The researchers found that 45-year-old males who followed 0-3 of these habits could expect to live to age 67; those who followed 4-5 habits could expect to live to age 73; and those who followed 6-7 habits could expect to live to age 78. The data for 45-year-old women showed a similar trend; however, the difference in life expectancy between the top and bottom groups was 7 years rather than the 11 years for men.

These studies tend to support the notion of the relationship between health practices and health. This certainly seems clear and straightforward, but in science it is necessary sometimes to confirm the obvious.

Studies like the ones discussed previously have given a great impetus to the concept of preventive health practices. It appears to be an idea whose time has come. One can scarcely pick up a scientific journal from the health or medical disciplines without finding an article or editorial suggesting that CHD or cancer can and should be prevented.[35,39-50] Politicians have also joined this movement.[51,52]

The most comprehensive and organized approach to the issue of preventive health practices has been presented by the Canadians.[53,54,55] Their approach to "Operation Life-Style" states (among other things) that:

1. It is better to be slim than fat.
2. It is better not to smoke cigarettes.
3. Excessive use of medication is to be avoided.
4. Exercise and fitness are better than sedentary living and lack of fitness.
5. Alcohol is a danger to health, particularly when driving a car.

I have tried to show that there are readily identifiable common-sense health practices that should be followed. If this is done, it is reasonable to expect improved health and longer life. It is perhaps also necessary to point out the obvious, that the responsibility for these life-style changes rests with the individual. A recent editorial in the *Journal of the American Medical Association* states, "Perhaps the most promising potential for improving the public health resides in what people can be motivated to do for themselves."[56] That is sound advice.

Major societal issues are on the circumference of the circle. It is my contention that these issues are related in part to the major causes of morbidity and mortality listed in the first ring of the circle. These health problems are further related to the intermediate steps depicted in the next ring. Finally, I propose that the health practices listed in the center are major causative factors related to the health problems and issues displayed in the model. It is also perhaps possible to extend the reasoning at least one more step. The initiation, establishment, and maintenance of these health practices is complicated. They are probably dependent upon environmental, cultural, and personal

factors and situations. Horn's model for Personal Choice Health Behavior is a theoretical example of how these factors interrelate.[57] The application of this and other models will be discussed later.

Efficacy of Prevention — Developing a Healthful Life-Style

If one agrees with our previous arguments, it is clear that Americans would benefit from changing certain health behaviors. In the minds of many, however, that assumption meets a major stumbling block. A widely held pessimistic view is that persons are unable to change these habits of long standing. Folk wisdom indicates, "you cannot teach an old dog new tricks," "you cannot change human nature," "people will not change health habits," or "more people are smoking now than ever before." I recognize that health-habit changes are not easy, but neither are they impossible. Americans are becoming more and more health conscious, in my opinion, and are making changes in greater and greater numbers. I will present some of the available evidence on trends for some of these habits, but perhaps a personal observational example illustrates the concept just as well. I have lived at my current address in Columbia for 6 years. When we first arrived, my wife and I were essentially the only joggers in the neighborhood. Now you see joggers going down my street from 6 AM to 11 PM. At any time I doubt that you would have to wait more than a few minutes to see the next one. I cannot quantify the amount of change in jogging behavior in my neighborhood, but I feel confident that it is simply astounding. It is also encouraging that all ages, sizes, ability levels, and both sexes are represented.

The proposition that people want to change health habits, are trying to change, and are being somewhat successful can be supported with hard evidence. It is clear that the studies reported represent isolated individual attempts at addressing the problem. We have not yet mounted a comprehensive, organized, and aggressive campaign, as has been proposed in Canada.[55] It is encouraging, however, that these individual projects are showing some positive results, and even more exciting to think about what can be done with an all-out effort.

One Swiss study offers hope for changing behavior in adolescence.[58] This four-year prospective study involved 120 male apprentices in machine factories. The subjects were assigned to a control group (N=60) and an experimental group (N=60). The subjects in the experimental group received a program of health education consisting of lectures and exhibits. Leisure-time physical activities were also encouraged. The findings after 4 years were impressive as shown in Table 1.

These data clearly show that the health education program did not cause smokers and drinkers to quit, but it did apparently prevent the experimental subjects from starting the habits. The participants also engaged in more physical activity, showed greater improvements in measures of physical fitness, and had fewer dental caries.

The Stanford University "Three-Community Study" has demonstrated that entire communities can be persuaded to change health behaviors.[59,60] In this study, one community was assigned as a control, one received health education via mass media, and the third received the mass-media campaign plus intensive intervention. The intensive intervention consisted of selecting 100 high-risk participants who were offered face-to-face intervention from behavioral scientists and dieticians. In the two experimental communities the mass-media campaign was directed by specialists in communications, medical science, and behavioral science.

The study design required a behavioral interview and a medical examination in all three communities. Surveys were conducted at baseline and repeat annual examinations for 2 years of follow-up. The behavioral interview consisted of a health knowledge component and also surveyed attitudes relative to health behavior change. The medical examination included measures of blood chemistry, blood pressure, weight, and ECG. A summary of the results after 2 years revealed no change in health knowledge or health behavior in the control community. The mass-media-only community had significant changes in both knowledge and behavior. The greatest knowledge and behavioral changes occurred in the community receiving the mass-media campaign plus intensive intervention.

The results of this study suggest that mass changes are possible and that they can be done inexpensively.

Although there has been no organized campaign, considerable effort has been expended in antismoking education. The surgeon general's report on smoking and health provided an impetus to smoking cessation efforts by voluntary health agencies and professional organizations.[61] Antismoking spots on television, community campaigns, and quit-smoking clinics have been used. The available data do not permit an analysis to determine specific causes for changes in smoking behavior, but significant changes have occurred.[62] National probability samples have been drawn and surveyed for smoking behavior for the National Clearinghouse for Smoking and Health. These surveys indicate that the prevalence of smoking in adults declined sharply from the mid-1960s to the mid-1970s. Smoking by adult men declined from 52 percent to 39 percent for a drop of 25 percent. For adult women the figures were 32.5 percent to 28.9 percent for a drop of 11 percent. Too many people are still smoking, but it is encouraging that significant decreases have occurred.

Data from the Hypertension and Detection Follow-up Program (HDFP) indicate an improvement in the treatment of hypertension.[63] Control of high blood pressure is demonstrably important but too few hypertensives are adequately treated. Only half the hypertensives are said to be aware of their condition, only half of these are being treated, and of those only half are adequately controlled. This "rule of the halves" predicts that only some 12 percent of the hypertensives are under adequate treatment. Recent studies cast doubt on that model. The HDFP survey found 38 percent of the hypertensives were controlled. Further evidence of this improved control of hypertension is available from Chicago,[64] where recent screening activities discovered only 12 percent previously undetected hypertensives compared to 57 percent four years

Table 1
Changes in Health Behavior Over 4 Years

	Cigarette Smoking		Alcohol Use	
	Initially	At end	Initially	At end
Experimental group	24	25	26	33
Control group	28	47	29	55

earlier. These data indicate a remarkable public-health achievement, and demonstrate what can be done with professional education coupled with public emphasis on the dangers of hypertension and the necessity of treatment.

It seems to me that there is ample evidence that the American public is concerned about health matters, and that people are attempting to change undesirable health habits. The crucial question, however, is whether these changes have been meaningful. Evidence suggesting that they have is available in the mortality statistics for the United States for the past 25 years.[65] Total mortality has declined 23.7 percent and cardiovascular mortality has declined 29.7 percent. Most of the decrease in cardiovascular deaths has occurred since 1968. All four major races and both sex groups show similar declines in mortality. Although many possible explanations exist for these decreases, including improved medical and hospital care, it appears reasonable to assume that at least some of the improvement can be attributed to improved risk-factor status. An excellent and extensive review of risk-factor trends and changes in mortality has been published by Stamler.[11]

Health Behavior Change — Why?

The question of what prompts health beahvior change has intrigued scientists. What dynamic factors are operating when a smoker of two packs per day for thirty years stops or someone who has been sedentary for two decades since college starts jogging? It is stating the obvious to say, "man is a complex creature, whose behavior is affected by many factors." In order for health behavior change to occur, cognitive and affective components as well as social interactions and environmental conditions are important. Theoretical models attempting to explain these processes have been presented.

Numerous scientists have contributed to the development of the Health Belief Model.[66] This model predicts that preventive health behavior will occur under a specific set of circumstances. A person will attempt to avoid a disease if certain beliefs are held: (1) personal susceptibility, (2) that the disease would be severe, (3) that taking action would be beneficial, (4) that the action will not present significant psychological barriers such as inconvenience or pain. A further component of this model is that some cue to action is important. A person might fervently hold the beliefs mentioned above and yet not make changes. Something is necessary to push him over the line. This cue to action might be the death of a friend or relative or something less traumatic such as a newspaper article about the disease and the target behavior. Other variables such as age, sex, ethnicity, social class, personality, etc., are also thought to play a role. Examples of the application of the Health Belief Model in behavior change research are available.[56,67,68]

A model on Encounter in Health Education has been developed by Burt.[69] This model includes a partnership between the health educator and participant. The participant is to evaluate selected life-style components, the health educator is to assist in an orderly evaluation. The major question about any particular life-style component is whether or not it is healthful, actualizing, and happiness promoting. Burt proposes that this evaluation proceed in a systematic fashion by progressing through a series of steps. These steps include separating knowledge from bias, rational from irrational thinking, examining hang-ups and priorities, confirmation or disconfirmation of a belief, and finally accepting or rejecting a particular life-style component. This particular model appears to place more emphasis on the role of the health professional as an agent of change.

A third model, Personal Choice Health Behavior (PCHB) has been presented by Horn.[57] This approach places more emphasis on a comprehensive view of health behavior, and is not limited to cessation of bad habits. According to Horn an individual proceeds through stages of initiation, establishment, and maintenance of a particular behavior. A behavior is more likely to be initiated if there is availability and an example to follow. It has been found, for example, that children of smokers are more likely to become smokers themselves.[70] The establishment of a behavior is influenced by such factors as costs-benefits analysis and psychological factors such as internal-external locus of control. The maintenance of a behavior is dependent, at least in part, on reinforcement, social support, and psychological utility. Cessation, or other modification, of PCHB involves some aspects similar to those presented in the Health Belief Model. Motivation for change may be influenced by one's values. Action may be taken if threat is perceived.

These models, and others similar to them, should help us begin to understand the complex interactions among individuals, their environment, and other demographic variables that relate to health behavior and health behavior change. It is clear to me that educators must move beyond the belief that the educational process will ensure the establishment of a healthful life-style in our students. Students do not stop using drugs after a lecture on drugs and the law by a local policeman. Venereal disease will not be controlled by showing films of syphilitic chancres. All teenagers will not stop smoking after seeing diseased lungs. We will not eliminate sedentary life-styles with lectures about CHD and low-back pain. I do not mean to denigrate the educational efforts that we are making. They are important and necessary, but they must be placed in perspective and fitted into a comprehensive pattern of developing a healthful life-style.

Health Behavior Change — How?

It would be encouraging to see sweeping changes and comprehensive program recommendations for life-style adjustments come from our institutions. The federal goverment has the resources to implement integrated programs utilizing interdisciplinary support. Coordination of these efforts at higher levels of the department of Health and Human Services (HHS) and a reordering of priorities would be necessary. Less emphasis, and less money, would need to be placed on treatment and more on preventive efforts. State or local governments through departments of public health, communications, and education could develop similar initiatives. Scholarly and professional associations from the medical, health, and behavioral sciences could also contribute. There are some signs that such developments are under way. News reports indicate that various institutes at NIH are beginning to place more emphasis on preventive health measures. During the Carter administration, Secretary Califano made repeated statements regarding DHEW's efforts in smoking control.[71] A consortium of government, professional societies, private industry, and education could have a marked impact on Americans' life-styles, but such a group is unlikely to be formed. In the first place, there is hardly unanimous opinion that these programs should be started. Second, powerful

interests such as the tobacco, egg, and dairy industries are likely to actively oppose preventive health programs. Third, the simple problem of overcoming inertia and organizing such a massive program is a Herculean task.

Should we then throw up our hands in despair, and wait for a more opportune time? I think not. The idea of preventing disease and achieving high-level wellness is an idea whose time has come. For example, approximately 90 percent of current adult cigarette smokers say that smoking is hazardous to health and that they would like to quit.[62] Furthermore, most smokers who have quit, did so without professional assistance.[72] Although the data are not available, I doubt that very many of the millions currently jogging began under professional supervision.

I am not suggesting that health professionals have had no effect on the health-behavior changes that have occurred. However, it seems likely that the effects have been indirect. Conducting an exercise class for adults may reach and influence a reasonably small number of people. There is probably a ripple effect as those participants talk to their friends, co-workers, and families, and as they begin to jog through their neighborhoods. Some of them may even start additional classes or perhaps initiate racing events. Professional influence is undoubtedly effective in other ways. Every newspaper interview or TV talk show reaches large numbers of people. Every speaking engagement at a service club, PTA, or other group reaches more. In at least some instances, those efforts may provide the cue to action described in the Health Belief Model.[66]

I would make several recommendations to professionals interested in promoting health-behavior change and high-level wellness.

1. Continue day-to-day responsibilties of teaching, counseling, and conducting research.
2. Keep in mind the niche these activities fill in a total health life-style model.
3. Seek to interrelate your own activities with others.
4. Be cognizant of the interdisciplinary nature of your work, and try to build on the strengths and abilities of others.
5. Utilize the theoretical models describing health-behavior change to plan future directions, new programs, and research.
6. Be a health activist and try to mobilize your community's resources to produce the integrated interdisciplinary programs of health-behavior change.

More specifically, for the worker in aerobic fitness programs, the following suggestions may be helpful.

1. We should attempt to integrate regular physical activity into a total life-style approach to good health. Advise participants in exercise programs about good nutrition, relaxation or stress management techniques, safety consciousness, and the benefits of smoking cessation.
2. Our exercise programs should be based on sound behavioral science principles. Several recent publications provide useful information on this point.[73-78]
   - Involve participants in the decision-making process relative to their personal health habits. Introspection and self-observation by the participant can identify potential pitfalls to success. Self-collected data on behavior can be useful in planning the change process.
   - Changes in health behavior should be done gradually. Few persons can completely reorganize their lives and change several habits at once. It may take months or even years to implement all desired changes. This slow but steady approach is more likely to produce lasting changes. It is also important to help participants set reasonable goals and undertand that the change process will likely be lengthy.
   - Professional support over long periods of time is important. Many behavior change programs fail because of lack of follow-up. Maintain contact with participants via post cards, telephone, newsletters; have them keep a diary or log and send it to you; and have occasional reunion or booster meetings.
   - The health professional should work to develop and improve counseling and communication skills. Ask open-ended questions that elicit more than a yes or no response, be open, honest, and assume an assertive approach to the counseling session.
   - Finally, be liberal in the use of positive reinforcement and support. Seek ways to provide feedback. Help the participant to design intrinsic and extrinsic systems of support and reinforcement. Use families and friends to provide this support.
3. It may also be useful to base your approaches on some particular health behavior change model. Read the papers on models, think about the various approaches, and discuss them with your fellow workers. An example of how this approach might be used is given for Horn's PCHB model in relation to regular physical activity. In this case the application of the model is for developing a positive health habit, so only the first three stages are applicable.

If one were to design an existence in which persons were to be likely to initiate regular activity, what would you do? According to the PCHB model, opportunities for activity should be readily available, examples should be evident, and perhaps it should be rewarding (either physically or emotionally). To meet those criteria for our example, one approach would be to make it convenient to exercise. This could mean plenty of facilities such as tennis courts, bike and jogging trails, swimming pools, etc. It might also be possible to concomitantly make it less convenient not to exercise; for example, sidewalks and paths rather than streets leading to shopping and recreation areas. It is important to have highly visible examples. Adoption of a new or innovative behavior or practice follows an S-shaped, exponential growth curve.[79] As more people adopt a behavior, the more likely others are to adopt it, at least until most of the population has changed and only a few die-hards are left.

According to the PCHB model a behavior may become established as a result of a costs/benefits analysis. For the case of exercise, if persons begin to feel good (both physically and emotionally) about their participation, and if costs (giving up time or disrupting schedules) are minimal, then the activity is more likely to become established. A perceptual stereotype may also develop. If a person begins to see himself or herself as an exerciser and like other exercisers, the habit may continue. Various psychological factors may also be important. If one receives positive reinforcement, the exercise is likely to be more firmly established.

Maintenance

According to Horn, at some point in

time either habituation or dependence becomes operative and the person is likely to maintain the behavior. I suppose that would be debatable as to whether regular runners become dependent or habituated. My feeling (in the absence of any data) is that they probably do both.

The foregoing discussion is a brief example of how a theoretical model may be used to plan and implement health behavior change projects. The creative and dedicated professional can think of many expansions and applications of some of the ideas.

Summary

I have tried to illustrate that the current American life-style contributes to our major health problems. In order for us to achieve high-level wellness certain health behaviors need to be changed. This message has been accepted by large numbers of Americans. Many beneficial changes have occurred in recent years and the mortality statistics show a decline. Organized programs for health behavior change have demonstrated success, but much remains to be done. Health status of Americans will improve if citizens take the responsibility for their own health and if dedicated health professionals serve as catalysts to promote changes in life-style.

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Objectives for the Nation—Physical Fitness and Exercise

Jack H. Wilmore

In 1979, the first Surgeon General's Report on Health Promotion and Disease Prevention, *Healthy People*, was issued. In that report, gains in health of the American people were chronicled over the previous century, existing preventable threats to health were identified and reviewed, and fifteen priority areas were selected in which further health gains could be expected over the decade with appropriate action. The priority areas identified included: high blood pressure control; family planning; pregnancy and infant health; immunization; sexually transmitted disease control; toxic agent control; occupational safety and health; accident prevention and injury control; fluoridation and dental health; surveillance and control of infectious diseases; smoking and health; control of the misuse of alcohol and drugs; nutrition; control of stress and violent behavior; and physical fitness and exercise. Broad national goals were established for the improvement of the health of Americans at the five major life stages: infancy, childhood, adolescence and young adulthood, adulthood, and older adulthood.

On June 13 and 14, 1979, the Department of Health, Education, and Welfare (now the Department of Health and Human Services) sponsored a working conference in Atlanta, Georgia, to define specific and quantifiable objectives necessary for the attainment of the broad goals outlined in the previous report, *Healthy People*. First drafts were developed by the 167 experts invited to attend this conference. Subsequently, more than 500 individuals and organizations from both the private and governmental sectors worked for over a year to refine the original drafts. An invitation for public comment was published in the *Federal Register*, and drafts were widely circulated to people and agencies concerned with the specific priority areas. Final revisions were made in the spring of 1980, and the final report, *Promoting Health /Preventing Disease: Objectives for the Nation*, was published in the fall of 1980.

The purpose of this article is to summarize the essence of the report and final draft of the Work Group on Physical Fitness and Exercise. This report, like each of the other 14 prevention areas, was presented in a standard format which included:

- the nature and extent of the problem, including health implications, status and trends
- prevention/promotion measures illustrative of approaches in education and information, services, technology, legislation and regulation, and economic incentives, followed by observations on the relative strength of these measures
- specific national objectives for: improved health status, reduced risk factors, improved public/professional awareness, improved services/protection, and improved surveillance/evaluation
- the principal assumptions that underlie the framing of the objectives
- the data necessary for tracking progress.

With 12 members in each working group, and a number of observers taking an active role in the initial deliberations, consensus was not always

Health benefits associated with regular physical fitness and exercise have not yet been fully defined. Yet based on what is now known it appears that substantial direct and indirect physical and emotional benefits are possible. It remains that most Americans do not engage in appropriate physical activity, either during recreation or in their work. The objectives for the nation speak for physical education professionals. We have a job to do—now.

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Only about a third of children and adolescents ages 10 to 17 are estimated to participate in daily school physical education programs, and the share is declining.

Only 2.5% of companies and institutions with more than 500 employees offer fitness programs for their workers.

achieved on each issue. The final document represents considerable compromise on the part of individual participants, but is one with which most or all of them feel reasonably comfortable. The following summary is taken from the original report.

Nature and Extent of the Problem

The health benefits associated with regular physical fitness and exercise have not yet been fully defined. Based on what is now known it appears that substantial physical and emotional benefits, direct and indirect, are possible. Yet most Americans do not engage in appropriate physical activity, either during recreation or in the course of their work. For the purposes of this discussion, "appropriate physical activity" refers to exercise which involves large muscle groups in dynamic movement for periods of 20 minutes or longer, three or more days per week, and which is performed at an intensity requiring 60% or greater of an individual's cardiorespiratory capacity. Exercise to improve flexibility and muscular strength may reduce the frequency of musculoskeletal problems and is an important supplement to cardiovascular conditioning activities.

Health Implications

- Most people feel better when they exercise
- Physical inactivity can result in decreased physical working capacity at all ages, with concomitant decreases in physiologic function and health status.
- Physical inactivity is associated with an increased risk of developing obesity and its disease correlates.
- Physical inactivity is associated with increased risk of coronary heart disease.
- Appropriate physical activity may be a valuable tool in therapeutic regimens for control and amelioration (rehabilitation) of obesity, coronary heart disease, hypertension, diabetes, musculoskeletal problems, respiratory diseases, stress and depression/anxiety. Such physical activity, however, is still not routinely prescribed for the treatment of these conditions.

Status and trends

- Though physical fitness and exercise activities have increased in recent years—and over 50% of adults reported regular exercise in popular opinion polls—generous estimates place the proportion of regularly exercising adults ages 18 to 65 at something over 35%.
- Regular runners include approximately 5% of all Americans over age 20, and 10% of men aged 20 to 44.
- About 36% of adults ages 65 and older were estimated in 1975 to take regular walks.
- Only about a third of children and adolescents ages 10 to 17 are estimated to participate in daily school physical education programs, and the share is declining.
- Many high school programs focus on competitive sports that involve a relatively small proportion of students.
- Though growing, the awareness of the health benefits of regular exercise is limited.
- Only a small proportion (about 2.5%) of companies and institutions with greater than 500 employees offer fitness programs for their workers.
- Certain groups demonstrate disproportionately low rates of participation in appropriate physical activity, including girls and women, older people, physically and mentally handicapped people of all ages, inner city and rural residents, people of low socioeconomic status and residents of institutions.

Prevention/Promotion Measures

Education and information measures include: using television and radio public service announcements to provide information on appropriate physical activity and its benefits; providing information in school and college-based programs; providing information in health care delivery systems; adopting an exercise component by community service agencies; assuring that all programs and materials related to diet and weight loss have an active exercise component; and tailoring education programs to the needs and characteristics of specific populations.

Service measures include: providing physical fitness and exercise programs to school children, and ensuring that those programs emphasize activities for all children rather than just competitive sports for relatively few; providing physical fitness and exercise programs in colleges; providing worksite-based fitness programs; and incorporating exercise and fitness protocols as regular clinical tools of health providers.

Technologic measures include: increasing the availability of existing facilities and promoting the development of new facilities by public, private and corporate entities; and upgrading existing facilities, especially in inner city neighborhoods, and involving the population to be served at all levels of planning.

Legislative and Economic Measures

Legislative and regulatory measures include: city council support for bicycle and walking paths for use in trips to work and school; developing and operating local, state and national park facilities which can be used for physical fitness activities in urban areas; increasing the number of school-mandated physical education programs that focus on health-related physical fitness; establishing state and local councils on health promotion and physical fitness; and allowing expenditure of funds of fitness-related activities under Federally funded programs guided by federal regulations.

Economic measures include: tax incentives for the private sector to offer physical fitness programs for employees; encouraging employers to permit employees to exercise on company time and/or giving employees flexible time for use of facilities; and offering health and life insurance policies with reduced premiums for those who participate in regular vigorous physical activity.

Professionals* must *make a personal commitment. How can we be effective in promoting health and fitness if our bodies are not living testimonies of our commitment? What we are communicates more than what we say!

Specific Objectives for 1990

Improved Health Status

- Increased levels of physical fitness may contribute to reduced heart and lung disease rates, possibly reduced injuries among the elderly, and more broadly an enhanced sense of well-being which may reinforce positive health behaviors in other areas.

Reduced Risk Factors

- By 1990, the proportion of children and adolescents participating regularly in appropriate physical activities, particularly cardiorespiratory fitness programs which can be carried into adulthood, should be greater than 90%.
- By 1990, the proportion of children and adolescents participating in daily school physical education programs should be greater than 60%, compared to 33% in 1974-1975.
- By 1990, the proportion of adults 18 to 65 participating regularly in vigorous physical exercise should be greater than 60%, compared to an estimated 35% in 1978.
- By 1990, 50% of adults 65 years and older should be engaging in appropriate physical activity such as regular walking, swimming, or other aerobic activity, compared to and estimated 36% taking walks in 1975.

Increased Public/Professional Awareness

- By 1990, the proportion of adults who can accurately identify the variety and duration of exercise thought to most effectively promote cardiorespiratory fitness should be greater than 70%.
- By 1990, the proportion of primary care physicians who include a careful exercise history as part of their initial examination of new patients should be greater than 50%.

Improved Services/Protection

- By 1990, the proportion of employees of companies and institutions with more than 500 employees offering employer-sponsored fitness programs should be greater than 25%, compared to approximately 2.5% in 1979.

Improved Surveillance/Evaluation Systems

- By 1990, a methodology for systematically assessing the physical fitness of children should be established, with at least 70% participation in such an assessment.
- By 1990, data should be available with which to evaluate the short and long-term health effects of participation in programs of appropriate physical activity.
- By 1990, data should be available to evaluate the effects of participation in programs of physical fitness on job performance and health care costs.
- By 1990, data should be available for regular monitoring of national trends and patterns of participation in physical activity, including participation in public recreation programs in community facilities.

Principal Assumptions

In formulating these objectives, a set of principal assumptions was adopted. It was assumed that increased physical activity by the American public will result in overall improvements in health, and that a personal commitment to enhance health will become a prominent factor promoting increased participation; that voluntary agencies, private corporations and government will expand their commitment to physical fitness programs, and private industry and retailers will support activities promoting physical fitness; that there will be a reversal of the trend in reductions of school-based programs aimed at promoting physical fitness, but that such programs will not necessarily be founded in the traditional physical education mold, and that new school-based programs will embrace activities which expand beyond competitive sports. Finally, the increasing costs associated with health care will compel public policy to emphasize measures such as physical fitness to enhance health.

Our Challenge

The objectives for 1990 have been clearly defined. Can we meet the challenge? Many states have already made substantial progress toward accomplishing some of these objectives, but many others are far behind. The American Alliance for Health, Physical Education, Recreation and Dance can and will provide the leadership at the top, but success in meeting these objectives depends primarily on the willingness of the membership to get involved.

Where does one start? First and foremost, each of us in the profession *must* make a personal commitment to achieve or maintain a good level of physical fitness. How can we be effective in promoting health and fitness if our bodies are not living testimonies of our commitment? What we *are* communicates so much more than what we *say!*

In addition to achieving optimal health status as individuals, we must join the national effort to reach the articulated goals for 1990. We must be dedicated to helping others, from the cradle to the grave, to understand that good health is more choice than chance. We are obliged as professionals to ensure a proper foundation of knowledge on which to make this choice, and a variety of opportunities for participation in health-promoting activity for those we teach.

Note

Sections of this article are adapted from *Promoting Health /Preventing Disease: Objectives for the Nation*, published in 1980 by the U. S. Government Printing Office. Orders for the book should be sent to the Superintendent of Documents, Government Printing Office, Washington DC 20402. Orders should include return address, check or money order for $5.00, title of the book and its stock number: 017-001-00435-9. $6.25 should be included for orders made from outside the U. S.

Definition of Health Related Physical Fitness and Exercise

A New Physical Fitness Test

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Photos courtesy of Department of Physical Education, University of South Carolina

In brief: In 1980 the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) developed a new fitness test to emphasize health-related physical fitness instead of motor/athletic fitness. The new test measures cardiorespiratory fitness, body composition, and low-back and hamstring strength and flexibility. These components can be measured in the field, reflect changes in exercise habits, and are related to some aspect of health.

Low-back/hamstring flexibility is judged by the sit-and-reach test. The students sit with legs extended and stretch forward as far as possible.

The preceding article has traced the historical development of physical fitness testing.[1] By the mid-1970s many members of the American Alliance for Health, Physical Education and Recreation (AAHPER) became convinced that the existing fitness test emphasis on motor/athletic fitness was inappropriate. In 1975 a joint committee was formed from within AAHPER's Association for Research, Administration, and Professional Councils and Societies (ARAPCS) to study the need for revisions in the AAHPER Youth Fitness Test. Three ARAPCS councils were represented: Measurement and Evaluation, Physical Fitness, and Research. The committee was chaired by A. S. Jackson of the University of Houston. The committee held working conferences, solicited professional input via

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Strength and endurance of the abdominal musculature is determined by the number of flexed-knee sit-ups performed in one minute. Arms are crossed on the chest with hands on the opposite shoulders.

AAHPER publications, and presented a convention program. Its work culminated in the publication of a position paper on the fitness test revision. The paper stated that it was time to differentiate physical fitness related to health from motor performance related to athletic ability.[2] The committee decided that this new health-related physical fitness test should include the following criteria:

1. Measure the spectrum of abilities from severely limited dysfunction to high levels of functional capacity.
2. Measure capacities that respond to appropriate physical training programs.
3. Accurately reflect an individual's physical fitness status as well as changes in functional capacity by corresponding test scores and changes in the scores.

The position paper with the above recommendations was forwarded to the AAHPER Board of Governors. In 1977 LeRoy Walker, AAHPER president, appointed Harold B. Falls as chair of a task force on youth fitness that was to implement the recommendations of the position paper and develop a new health-related physical fitness test. The task force held several working conferences and again solicited input from AAHPER members. The Board of Governors gave final approval of the new test in November 1979, and a test manual was published soon after.[3]

A technical manual that will include the scientific basis for the various test items will also be published. A detailed rationale for each item will be presented along with information on reliability and validity, details of the norming procedures, and descriptive statistics associated with the test items. The task force felt quite strongly that completion of the technical manual was an important aspect of its work. It represents a milestone as far as test publication by AAHPERD is concerned. It is the first attempt to provide

this type of information to users of an AAHPERD test. It should also provide a base and stimulus for much needed additional research on health-related physical fitness.

The Health-Related Physical Fitness Test

Components of health-related fitness that meet the criteria established by the AAHPER committee are cardiorespiratory fitness, body composition, and low-back and hamstring strength and flexibility. These components can be assessed in the field, reflect changes in exercise habits, and are related to some aspect of health. Other fitness or motor performance components that met some but not all of these criteria were not included. For example, the task force had lengthy debates on whether an upper extremity test of strength and endurance should be included. This quality is certainly important for some sports and other leisure-time activities as well as some occupational tasks. Therefore, activities to develop strength and endurance of the upper extremities and tests to assess programs are appropriate for physical education curriculums. However, arm strength and endurance cannot be related to health status in any very direct way, so the health-related physical fitness test does not include items such as push-ups or pull-ups. Variables such as nutritional status are obviously important to health status but are not subject to improvement by physical activity and also were not included.

Triceps and subscapular skinfolds were included in the test battery because these sites are relatively accessible and easy to obtain.

Cardiorespiratory Fitness. This component of health-related fitness has received a great deal of emphasis, and many physical fitness tests over the past several decades have attempted to assess cardiorespiratory function. Although cardiorespiratory fitness does not directly affect such variables as coronary heart disease risk factors, it is clearly associated with them.[4] A high level of cardiorespiratory function does not cause a more favorable lipoprotein profile; regular, dynamic, vigorous, large-muscle physical activity causes changes in both cardiorespiratory function and lipoprotein profile. Thus, cardiorespiratory function is a good marker for one's exercise habits (although we recognize the confounding effects of genetic factors).

High levels of cardiorespiratory function indicate a high physical work capacity (PWC)—the ability to release relatively large amounts of energy over an extended time. A high PWC has numerous advantages for leisure and occupational pursuits.[5] There is ample evidence that cardiorespiratory function responds to training[6] and that it can be validly assessed by field techniques.[7]

A distance run is used in the health-related

Triceps and subscapular skinfolds correlate highly with total body fat.

fitness battery to assess cardiorespiratory function. Extensive experience with this item has shown it to be administratively feasible in a variety of settings.[8-11] A teacher may elect to use a 1-mile run for time or a run in which students are instructed to run as far as they can in nine minutes. Students 13 years of age and older may use a 1.5-mile run for time or a 12-minute run for distance. Students are allowed to walk in all of these distance run tests, but they are encouraged to do their best. Students with medical problems that contraindicate vigorous exercise are not allowed to participate in these running tests. Furthermore, it is recommended that students be given some instruction and practice in distance running before testing. Teachers are encouraged to include appropriate warm-up and cool-down activities before and after the test. Specific details of test procedures are thoroughly described in the test manual.[12] Suggestions for administering the test on a regulation track, 100-meter straightaway, or playing field are given in the manual.

Body Composition. Body composition is defined as the relative percentage of fat and fat-free body mass. Excessive body fat is a health hazard and has been implicated as contributing to a variety of conditions including hypertension, hyperlipoproteinemia, and accident proneness.[12,13] While all the mechanisms of how excess fat causes these problems have not been completely explained, few health authorities would argue with the statement, "It is better to be lean than to be fat."

Body composition is a function of caloric balance, and although the emphasis has traditionally been on the caloric input side of the equation, we are now increasingly aware of the importance of energy output in regulating body weight.[14-16] Short-term experimental trials[6] and large-scale community studies[17] show that vigorous physical activity helps to reduce body fat.

Body composition not only is important to health and influenced by exercise, but it is also a massive public health problem,[18] and thus deserves increased attention in fitness testing. There has been some question whether body composition can be assessed in the field on a mass basis by relatively untrained testers. Reliability and validity studies using skinfold measurements to assess body composition convinced the task force that field assessment was feasible.[19] The task force believed that measurement difficulties notwithstanding, it is important to assess body composition because of the measurement's relation to the operational definitior of fitness. It lets students know what we think is important. Concern over the cost of skinfold calipers was alleviated by studies showing high validity and reliability of inexpensive new models.

Triceps and subscapular skinfolds were selected for inclusion in the test battery. These sites are relatively accessible, and skinfold measurements easy to obtain. They also correlate highly with total body fat. In addition, national norms are available from the Health and Nutrition Examination Survey.[20] Specific procedures for measuring these skinfolds are in the test manual.[3] Teachers who are inexperienced in taking skinfold measurements are encouraged to practice and obtain a consistent reproducibility of measurement of 1 to 2 mm or less.

Musculoskeletal Function. One aspect of strength, endurance, and flexibility that can be related to health involves the lower back/posterior thigh area. Low back pain is a relatively common malady that causes much disability.[21] Clinical evidence implicates lack of flexibility in the lower back/hamstring muscle groups combined with relatively weak muscles of the abdominal wall as the cause of a majority of low back pain cases. Physical therapists have long known that most people with these problems can have the condition corrected with appropriate exercises. Recent experience with the Y's Way to a Healthy Back program suggests a preventive role of exercise as well.[22,23]

Assessment of these fitness components in the field is relatively easy. Strength and endurance of the abdominal musculature is determined by the number of flexed-knee sit-ups performed in one minute. For this test,

students lie on their backs with the knees flexed, feet on the floor, and heels 12 to 18 in. from the buttocks. Arms are crossed on the chest with hands on the opposite shoulders (this prevents using the arms to gain momentum and help lift the trunk from the floor). The feet are held down by another student. The sit-up is executed by curling the trunk (chin tucked on the chest) and raising to an upright position. It is completed when the elbows touch the thighs. The sit-up test is scored as the number of correctly performed sit-ups in one minute. As with all fitness test items, reliability and validity can be improved with prior instruction and practice. More detailed instructions are given in the manual.[3]

Low-back/hamstring flexibility is judged by the sit-and-reach test, in which a person stretches his or her hands as far forward as possible toward or past the toes while in a sitting position. The test is administered with an easily constructed plywood cube with 30-cm (12-in.) sides. The top side is extended 23 cm (9 in.) past the edge of the cube and is marked in centimeters. The student sits on the floor with legs completely extended and with the feet touching the front edge of the cube. The 23-cm (9-in.) top overhang extends towards the student. The student's hands are placed one on top of the other on this centimeter scale. The objective of the test is to stretch forward as far as possible and hold for one second. The legs must be kept extended (another student can place a hand on the subject's knees to hold them down). The sit-and-reach score is easily obtained by reading from the centimeter scale. Students should be given instruction in the test procedure and allowed to warm up before testing. A complete description of the testing box and more detailed instructions for administration are given in the manual.[3]

Photograph courtesy of the American Running and Fitness Association

Cardiorespiratory function is assessed by a distance run. Teachers may elect to use a 1-mile run for time or a nine-minute run for distance.

Test Standards

Norm-Referenced Standards. Establishment of standards for a fitness test raises a difficult issue, particularly when the test purports to measure health fitness as opposed to athletic fitness. Two approaches to development of standards for fitness tests have been used. The traditional approach has involved measurement of a large number of individuals and calculation of percentiles for each test item. Such norm-referenced standards permit comparison of any individual's scores with the norms. This technique is conceptually logical for athletic fitness tests in which we might conclude that "faster is always better." However, the practical significance of percentile norms is less clear when applied to a test of health fitness. Suppose, for example, that the population as a whole is quite fit according to some criterion. That is, the entire distribution is shifted to the right. In such a case an individual might score at the 15th percentile and yet still possess an adequate amount of the characteristic being evaluated. Conversely, if the normative population was quite unfit, a score at the 90th percentile might still not be adequate in terms of health status.

Criterion-Referenced Standards. This problem has led some measurement experts to recommend establishment of criterion-referenced standards.[24,25] Developing criterion-referenced standards requires the use of

expert judgment to establish an "acceptable" and a "good" standard for each test item. With tests of health fitness this approach is philosophically attractive because the desired goal is good health, not maximal performance. However, there are practical problems associated with establishment of criterion-referenced standards for health-fitness test items in children. Because many of the health problems related to low fitness do not manifest themselves until middle or late adulthood, we need to know the level of fitness in children that is associated with minimal health risks in adulthood. Such knowledge is not presently available.

Confronted with this dilemma, the task force adopted a compromise. First, percentile norms were developed by testing 12,000 children from ages 5 to 17 in 13 states. Tests, excepting the skinfolds, were administered in a standardized manner by volunteer physical education teachers. Percentile norms for the skinfold tests were obtained from the National Health Examination Survey.[20] The test manual contains age- (5 to 17 years) and sex-specific percentile norms for each item.

For related articles, see pages 19 and 77.

In an effort to address the need for criterion-referenced standards, recommendations for interpretation of test results have been included in the test manual. Key recommendations are:

1. The 25th percentile in each test is considered the minimal acceptable score, and children ranking below this level should be provided with remedial training.

2. The 50th percentile is achievable by most children with proper conditioning, and it is recommended that all children strive to attain at least this level on all test items.

Although these guidelines are based on percentiles and do not constitute criterion-referenced standards in the pure sense, an effort had been made to apply "expert judgment" to the interpretation of the test scores. We hope that our knowledge base will expand in the future to allow development of true criterion-referenced standards.

Uses of the New Test

The educational significance of a nationally promoted physical fitness test cannot be overemphasized. Advertising reaches a large proportion of the physical education instructors in this country as well as many in other parts of the world. Physical education professionals are responsible for promoting overall health and wellness, and physical fitness is an important aspect of that. The tests we use and promote should measure components of health-related fitness identified as important by professional consensus. By doing so, we can show our youth that health-related physical fitness contributes to quality living for everyone in our society.

Because they measure athletic ability, most of the items on the Youth Fitness Test have an inherent element of competitiveness. The student compares his or her performance with others, and the test result often becomes an end in itself. On the other hand, the emphasis of the Health-Related Physical Fitness Test is toward achieving an optimum score that represents positive health status. The test is thus a means to an end. To foster this, the task force has provided a chapter in the manual titled "Guidelines for Physical Fitness Maintenance and Development." In it the teacher and student are provided aid in using the test results for improvement on each component assessed. The student is encouraged to improve and/or maintain his or her health and learn the important components of health-related fitness. In this regard, the test and its use have exceptional carry-over value into adult life because it is those same components with which the students will want to be concerned as they grow older.

The new health-related test also can be useful for physicians and other medical practitioners. As primary prevention of disease becomes a more powerful focus of the medical community, inexpensive screening procedures for low-risk patients will be in demand.

Tests such as the health-related fitness test could be administered in the traditional school environment with results being referred on to the child's personal physician. Medical groups are coming to recognize that physical fitness is a key component of a person's overall health profile. Thus it seems likely that tests of health fitness will come into wider use in the clinical setting in the future.

Summary

A new phase of physical fitness testing is under way. Emphasis is now given to health-related rather than motor performance items. This new trend seems consistent with recent research on the effects of exercise on health and also with the current trend of participation in aerobic exercise by millions of Americans. Broad implementation of the test and further diffusion of the health-related fitness concepts needs to be continued. A consortium of exercise physiologists, physical educators, physicians, and other health professionals can help achieve acceptance.

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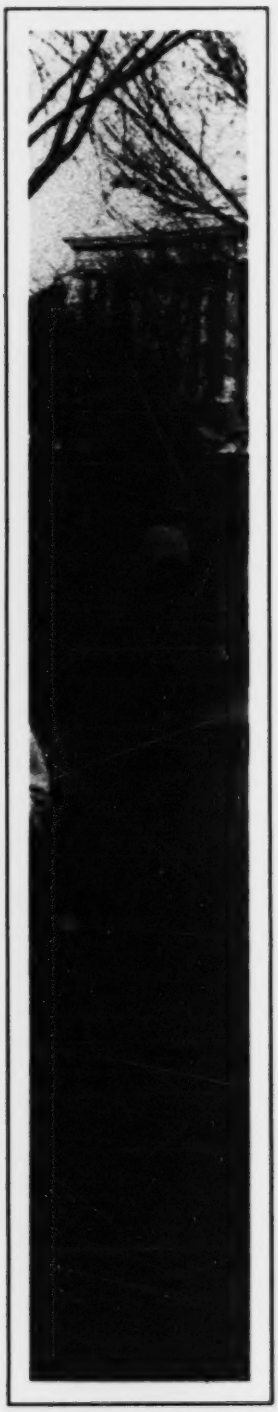
Scientific Basis



Health Related Physical Fitness

In 1980 the American Alliance inaugurated a Health Related Physical Fitness Test (HRPFT). The new test battery was designed to evaluate those physical fitness components associated with prevention of disease and promotion of physical health. The fitness components selected for evaluation were cardiorespiratory endurance, body composition and neuromuscular function of the lower trunk (muscular strength/endurance and flexibility). The designated test items are as follows:

Cardiorespiratory endurance	One mile run or Nine minute run
Body composition	Sum of triceps and subscapular skinfolds
Neuromuscular function of lower trunk	
Abdominal muscle strength and endurance	One minute sit-up
Lower back/hamstring flexibility	Sit-and-reach

The Alliance Health Related Physical Fitness Test represents a marked departure from the fitness testing practices and philosophies that have prevailed over the past thirty years. Philosophically the HRPFT reflects a heightened appreciation of the contribution regular exercise can make to maintenance of good health. This philosophical shift has been spurred by the rapid expansion of the body of knowledge linking physical fitness to disease prevention. The new test, in focusing exclusively on health related fitness components, does not purport to measure "overall fitness" or "athletic fitness." Its philosophical base, therefore, is substantially different from that of many previously established physical fitness tests.

On a practical level the HRPFT prescribes the use of several test items that have not been included in traditional fitness test batteries. For example, the new test recommends distance runs which are longer than those used in traditional tests and employs skinfold measures to assess body composition.

Tests of distance running ability have come into common usage over the past ten years. Such tests have proved to be acceptably valid predictors of maximal oxygen consumption (weight relative) and are relatively easy to administer. However, interpretation of distance run test results is not always a straightforward matter. Kirk Cureton's discussion of these tests provides guidance regarding their interpretation and research concerning their validity as measures of cardiorespiratory capacity.

One of the most novel components of the Alliance HRPFT is the skinfold test. While skinfold measures have been used for many years in research and in assessing body composition in adults, only recently have they become widely used with children. The HRPFT Manual provides percentile norms for skinfold measures but does not provide norms for percentage of body fat. T.G. Lohman explains why this approach was adopted and discusses our current knowledge of body composition assessment in children.

The HRPFT is a state-of-the-art field measure of health fitness. Research may never settle all the debates and answer all the questions raised by adoption of the HRPFT. However, it can lead to the development of improved fitness tests and to the better use of existing tests.

Russell R. Pate,
Editor

Distance Running Performance Tests in Children

What Do They Mean?

Kirk J. Cureton

Distance running performance tests are widely used as part of a battery of test items to evaluate the physical fitness of children. The American Alliance Youth Fitness Test, the American Alliance Health Related Physical Fitness Test, the Texas Physical Fitness/Motor Ability Test, and the South Carolina Physical Fitness Test, for example, all include a running test of 600 yards to 1.5 miles in distance or 9 to 12 minutes in duration. The purpose of these tests is to evaluate "endurance" or "cardiorespiratory capacity or endurance." The use of distance running performance tests to evaluate cardiorespiratory capacity in children has been criticized because of individual differences in other factors relating to children, such as body fatness, running skill or efficiency, motivation, and use of proper pace.[1,2]

Are distance running performance tests in children valid indicators of cardiorespiratory capacity? This question has been debated for years and it is not simple to answer. To answer it we must also ask: What is an acceptable criterion of cardiorespiratory capacity, and to what degree are distance running performance and cardiorespiratory capacity related in typical populations of children?

Most exercise physiologists agree that the maximal oxygen uptake ($\dot{V}O_2$ max) is a good overall measure of the cardiorespiratory capacity.[3] $\dot{V}O_2$ max in $l \cdot min^{-1}$, however, is strongly related to body size, especially during the years of growth and development,[4] and thus is most often expressed relative to body weight, in $ml \cdot kg\ BW^{-1} \cdot min^{-1}$, or, relative to fat-free weight, in $ml \cdot kg\ FFW^{-1} \cdot min^{-1}$, in an attempt to adjust for differences in body size. In studies evaluating the validity of distance running tests, $\dot{V}O_2$ max ($ml \cdot kg\ BW^{-1} \cdot min^{-1}$) is the expression most widely used to measure cardiorespiratory capacity.[5]

A strong case can be made, however, against $\dot{V}O_2$ max ($ml \cdot kg\ BW^{-1} \cdot min^{-1}$) as the acceptable criterion of cardiorespiratory capacity. In addition to reflecting cardiorespiratory capacity, this measure is also related to the degree of body fatness (% fat).[6,7,8] Because % fat negatively affects both $\dot{V}O_2$ max ($ml \cdot kg\ BW^{-1} \cdot min^{-1}$) and distance running performance,[2,8] correlations (validity coefficients) between $\dot{V}O_2$ max ($ml \cdot kg\ BW^{-1} \cdot min^{-1}$) and distance running performance reflect, in part, the negative influence of % fat on both measures. Buskirk and Taylor[6] concluded many years ago that $\dot{V}O_2$ max expressed relative to fat-free weight was probably the best available measure of cardiorespiratory capacity, because it is not affected by body fatness. Although investigators have acknowledged $\dot{V}O_2$ max ($ml \cdot kg\ FFW^{-1} \cdot min^{-1}$) to be the best criterion,[9] few have used it in the validation of distance running tests, assuming that $\dot{V}O_2$ max ($ml \cdot kg\ BW^{-1} \cdot min^{-1}$) was adequate.

The importance of using the appropriate criterion of cardiorespiratory capacity can be seen by comparing the correlations of $\dot{V}O_2$ max ($ml \cdot kg\ BW^{-1} \cdot min^{-1}$) and $\dot{V}O_2$ max ($ml \cdot kg\ FFW^{-1} \cdot min^{-1}$) with distance running performance tests. Table 1 contains correlations of a number of studies on adults and one study on children. $\dot{V}O_2$ max ($ml \cdot kg\ FFW^{-1} \cdot min^{-1}$) correlations with distance runs are consistently lower by an average of about .2. This trend is independent of the length of the running test. The average correlation between $\dot{V}O_2$ max ($ml \cdot kg\ FFW^{-1} \cdot min^{-1}$) and distance running performance in these studies (approximately .5) indicates that only 25% of the variance in distance running performance is related to cardiorespiratory capacity, whereas an average of almost 50% of the variance on distance running tests is related to $\dot{V}O_2$ max ($ml \cdot kg\ BW^{-1} \cdot min^{-1}$). Since the only difference in the two

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$\dot{V}O_2$ max expressions is the presence or absence of fat weight (in the denominator), variability in body fatness accounted for almost half of the relation between $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1}) and the distance running performance tests in the samples cited. Basing the validity of distance running tests as measures of cardiorespiratory capacity on correlations with $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1}) has left the mistaken impression that the correlation between cardiorespiratory capacity and distance running performance is stronger than it really is and, therefore, that the validity of these tests is better than it really is.

In studies that have used samples of at least 25 children or adolescents and distance runs of approximately one mile or more in distance or 9 minutes or more in duration, correlations between distance running performance and $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1}) have ranged from approximately .6 to .8,[2,10,11] indicating that, on the average, approximately one-half (50%) of the variance on distance running tests reflects variance in $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1}). Although limited data on the relation of $\dot{V}O_2$ max (ml · kg FFW^{-1} · min^{-1}) and distance running performance in children are available,[2] Table 1 suggests that only 25% or less of the variance in distance running performance is actually related to cardiorespiratory capacity in children. This degree of association is certainly too low to interpret distance running tests as reflecting predominantly cardiorespiratory capacity.

If distance running performance tests in children do not predominantly reflect cardiorespiratory capacity, as the relatively low correlations with $\dot{V}O_2$ max (ml · kg FFW^{-1} · min^{-1}) indicate, what do they measure? Research on both children[2] and adults[12] indicates that the biological determinants of distance running performance are complex. Biological variables, including cardiorespiratory capacity, body fatness, anaerobic threshold and running efficiency or skill (and others), have significant independent effects on distance running performance. The relative importance of these factors varies depending on the degree of variability of each within the population studied. In groups heterogeneous in level of physical condition, body fatness, and running skill, no single physiological variable accounts for a predominant proportion of the variance in distance running tests. Consequently, interpretation of distance running test scores should not be simple, implying that they reflect only a single physiological attribute.

Based on an average correlation of approximately .7 between $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1}) and distance running performance, and on studies that have used multiple regression to evaluate the relative importance of several of the determinants of distance running performance,[2,12] it appears that the combination of differences in body fatness and cardiorespiratory capacity may account for as much as half of the variance on a distance running performance test. Differences in running skill and efficiency account for additional variance in adults and probably in children, although there is little direct information on this relationship in children. Differences in the extent to which anaerobic energy is used, in motivation, and in the use of proper pace probably contribute to performance as well. This variable is particularly important in children, who often have short attention spans and who may be inexperienced in distance running.

It is frequently argued that while *differences* between individuals on distance running performance tests may not reflect only cardiorespiratory capacity, *changes* in distance running performance within an individual, particularly improvements associated with endurance training, are valid indicators of *changes* in cardiorespiratory capacity. This conclusion is based on the fact that endurance training in both adults and children improves cardiorespiratory capacity. Although improved cardiorespiratory capacity can improve distance running performance in an individual, other factors affecting distance running performance also change quite dramatically during the years of growth and development. Without a control as reference, it is usually impossible to distinguish growth and/or maturation related changes from changes related to physical activity.

Based on the 50th percentile values for the 9-minute run norms published by the Alliance,[13] distance running performance improves steadily in boys between the ages 5 and 17. Distance running performance in girls also improves over these ages, but at a slower rate after age 12. $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1}) in boys remains constant over this period of years (after age 7), whereas in girls it remains constant up to age 12 and tends to decline during adolescence.[4] An important reason for the systematic increase in running performance during the years of growth and development appears to be an age-related improvement in running efficiency; the $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1}) required to run at various submaximal

Table 1. Comparison of Correlations Between Distance Running Tests and VO_2 max Expressed Relative to Body Weight and Fat-Free Weight

Source	Sample	Distance Run	r with $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1})	r with $\dot{V}O_2$ max (ml · kg FFW^{-1} · min^{-1})
Falls et al.[17]	87 men, ages 23–35	600-yard run	−.64	−.48
Katch et al.[18]	25 college men	10-minute constant pace endurance run	−.62	−.33
Gilin et al.[19]	18 men, ages 25–35	3-mile run	−.69	−.43
Burke[20]	44 men, ages 17–30	1-mile run	−.74	−.66
		12-min run	.90	.85
Cureton et al.[9]	196 boys and girls, ages 8–12	600-yd. run	−.62	−.32
		1-mile run	−.66	−.40
Sparling et al.[14]	84 males, ages 18–35	12-min run	.69	.62
	34 females, ages 18–35	12-min run	.63	.48
Mean			.68	.50

speeds decreases systematically between ages 5 and 17 in both boys and girls.[4] A longitudinal study by Daniels and Oldridge[14] supports this conclusion. They found that improvements in distance running performance in 14 boys, ages 10 to 15 years, over a 22-month period of training were associated with a progressive improvement in running efficiency. $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1}) did not change significantly during the study.

Age-related changes in body fatness[15] and anaerobic capacity[4] also occur in both boys and girls and probably contribute to age-related changes in distance running performance. Both of these variables can change with training. The increase in % fat in girls that occurs following puberty is particularly important in explaining the progressive widening of the sex difference in distance running performance that develops during adolescence. The increase in body fat is regarded as the primary cause of the decrease in $\dot{V}O_2$ max (ml · kg BW^{-1} · min^{-1}) that occurs in girls during this period.[4] In equally trained young adult men and women, the sex difference in body fatness may account for as much as 70% of the sex difference in distance running performance.[12]

It is clear that changes in distance running performance, particularly those that occur over a period of years, occur as a result of a number of biological changes. There appears to be little evidence to support the claim that changes in distance running performance in a given child necessarily reflect changes in cardiorespiratory capacity, any more than do differences in distance running performance between children.

If a number of factors contribute to individual differences in distance running performance, and distance running tests do not reflect only cardiorespiratory capacity, are distance running tests valuable in the assessment of physical fitness in children? The answer to this question is an unqualified, Yes. Distance running tests evaluate a unique physical ability that is an important component of many other physical tasks. Factor analytic studies have clearly shown that distance running tests assess underlying abilities and physiological capacities that are different from those assessed with runs of shorter duration.[16,10] More importantly, however, because distance running tests require relatively prolonged exertion, they also reflect the level of energy expenditure that a person can sustain over an extended period of time, or the physical work capacity in weight-bearing exercise. Performance on distance running tests reflects, to some extent, the capacity for performance in other weight-bearing tasks requiring similar high levels of energy expenditure. Along side their use in evaluating one type of motor skills, this is probably the most significant meaning of such tests in relation to physical fitness.

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Measurement of Body Composition in Children

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Research in recent years on obesity has focused on children and the relation of childhood obesity to adult obesity. Identification and treatment of obesity in children is believed to be an important factor in its control during the adult years. There is a need, therefore, for the development of valid laboratory and field methods of estimating body composition in children of all ages. Valid laboratory methods are needed to establish standards and norms for percent fat in children. Practical field methods are needed to enable practitioners to estimate body composition in children within tolerable limits of error and without extensive training. At present neither valid laboratory methods nor field methods have been developed to estimate body composition in children, although good strides have been made in this direction and the prognosis for future success is good.

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Laboratory Methods

The most often used laboratory methods for body composition measurement in children are those that yield estimates of body density, body water content, and body potassium content. All are based on the assumption that children are chemically mature with a fat-free body density of 1.10 gm/cc, a water content of 72%, and a potassium content of 2.66 gm/kg of fat-free body. Using these methods in prepubescent children, a mean fat content of 20% is usually found. For example, Boileau[1] found a mean density of 1.052 gm/cc for 8 to 11 year old children measured in Illinois and 1.056 gm/cc for 8 to 11 year olds measured in Davis, California. Using Siri's[2] equation for converting density into fat content (% fat = 495/density − 450), we find that these children have a predicted fat content of about 20%. Mellitis and Cheek[3] and Schutte[4] found a water content of about 60% in 10 to 12 year old children. This 60% water content gives a predicted fat content of 17% in children, assuming a 72% fat-free body water content. Lohman and others[5]

Table 1. Percentile Norms. Ages 6-18[a] for Sum of Triceps plus Subscapular Skinfolds (mm) for Girls[b]

Age	6	7	8	9	10	11	12	13	14	15	16	17
Percentile												
99	7	7	7	7	7	8	8	7	7	8	8	8
95	8	9	9	9	9	9	9	9	9	9	9	9
90	9	9	9	10	10	10	10	10	9	10	10	10
85	10	10	10	10	11	11	10	10	10	11	11	11
80	10	10	10	11	11	12	11	11	11	11	11	12
75	11	11	11	11	12	12	11	12	11	12	12	12
70	11	11	11	12	12	12	12	12	12	12	12	13
65	11	11	12	12	13	13	13	12	12	13	13	13
60	12	12	12	13	13	14	13	13	13	13	13	14
55	12	12	13	13	14	15	14	14	13	14	14	14
50	12	12	13	14	14	16	15	15	14	14	14	15
45	13	13	14	14	15	16	15	16	14	15	15	16
40	13	13	14	15	16	17	16	17	15	16	16	16
35	13	14	15	16	17	19	17	18	16	18	17	17
30	14	14	16	17	18	20	19	19	18	18	18	19
25	14	15	17	18	19	22	21	22	20	20	20	21
20	15	16	18	20	21	24	24	25	23	22	22	24
15	16	17	19	23	24	28	27	29	27	25	24	26
10	18	18	21	26	28	33	33	36	31	30	29	30
5	20	24	28	34	33	38	44	46	37	40	37	38

[a]The norms for age 17 may be used for age 18.

[b]Based on data from Johnston, F. E., D. V. Hamill, and S. Lemeshow. (1) *Skinfold Thickness of Children 6-11 Years* (Series II, No. 120, 1972), and (2) *Skinfold Thickness of Youths 12-17 Years* (Series II, No. 132, 1974). U.S. National Center for Health Statistics, U.S. Department of HEW, Washington, DC[13]

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found 8 to 11 year old boys to average 73.4 grams of potassium. Assuming 2.66 gm/kg of fat-free body, the fat content estimate was 20.4%. Similar results have been found by Forbes and Amirhakimi.[6]

J. Brozek has pointed out that we know very little about the chemical maturation of the fat-free body in man.[7] Data available in infants indicate a higher water content and lower potassium and mineral content of the fat-free body. Various animal species reach chemical maturity around puberty—at about 4% of their life span. This 4% in man corresponds to 3 to 4 years of age, much before puberty. It is, therefore, reasonable to suspect that children between 4 and 14 years of age may not be chemically mature and may have a higher water content and lower potassium and mineral content. Both of these components, water and mineral, would act to lower overall body density; not because a child is fatter but because a higher water content and lower mineral content lead to overall lower body density. The lower density values commonly found in children might be explained on this basis. The result of this uncertainty regarding fat-free body composition in children is a reluctance to use the constants of 1.10 gm/cc, 72% water and 2.66 grams of potassium per kilogram of fat free body that are used for adults. Current research now underway should help to establish these developmental changes in fat-free body composition.

Field Methods

Skinfolds, circumferences and skeletal widths have been used to estimate body composition in several populations of subjects. Practical approaches have been developed for adult men and women ranging in age from 20 to 50.[8,9,10] Equations for predicting body composition from anthropometric dimensions appear to be valid for various populations of this age group although additional cross validation is needed. Standard errors of prediction from these equations for an individual are usually between 3 and 5% fat.

For children, anthropometric dimensions are also helpful in predicting percent fat as estimated from body density or potassium. Standard errors of estimate are only slightly larger than in adults. However, the prediction equations applicable to adults do not apply to children.

The relationship between anthropometric dimensions and body density appears to vary between 8 and 15 years of age. Further research is needed to determine when this relationship becomes stable. Until such research is conducted, the relationship between anthropometric dimension and body density cannot be used for quantification of body fat content in children. The most valid approach for body composition prediction using field methods at present is to use normative anthropometric data rather than convert skinfolds, circumferences or skeletal widths. This approach was adopted for the new AAHPERD Health Related Fitness Test which utilizes skinfold data obtained from the National Health Survey collected on 13,882 children between 6 and 17 years of age. These norms, based on the sum of two skinfolds, are presented in Tables 1 and 2. Children with skinfolds below the 25 percentile are encouraged to reduce body fatness through an increase in physical activity and a decrease in caloric intake.

Whenever an indirect method is used to estimate body composition, it is important to be aware of its limitations. We cannot at present estimate body fat content from anthropometric dimensions for children, for example. Moreover, the measurement error of inexperienced investigators can be somewhat larger than experienced investigators, and completely erroneous values have been obtained due to faulty technique.[10] Until one hundred children have been measured, it is inadvisable to convert the scores obtained to percentiles, as in Tables 1 and 2. Furthermore, the national norms were developed using the Lange skinfold calipers. Results from other calipers may be different.

To aid in the measurement of skinfolds, detailed procedures have been described in the new Health Related Physical Fitness Manual and in the article by Lohman and Pollock.[11] For the first year of measurement, two instructors should independently measure all children. A check on measurement error can be made by comparing the results. Two out of three measurements should fall within 3 mm at both the triceps and subscapular sites. If consistently larger errors are found, techniques should be compared so as to find the sources of variation. Finally, novice measurers should attend a workshop on the new Fitness Test and should contact their state representative about plans for testing. Names of state representatives are published in this issue. By attending a workshop, proper techniques can be developed. This will be of great help in standardizing the measurement procedure nationwide.

Table 2. Percentile Norms. Ages 6-18[a] for Sum of Triceps plus Subscapular Skinfolds (mm) for Girls[b]

Age	6	7	8	9	10	11	12	13	14	15	16	17
Percentile												
99	8	8	8	9	9	8	9	10	10	11	11	12
95	9	10	10	10	10	11	11	12	13	14	14	15
90	10	11	11	12	12	12	12	13	15	16	16	16
85	11	12	12	12	13	13	13	14	16	17	18	18
80	12	12	12	13	13	14	14	15	17	18	19	19
75	12	12	13	14	14	15	15	16	18	20	20	20
70	12	13	14	15	15	16	16	17	19	21	21	22
65	13	13	14	15	16	16	17	18	20	22	22	23
60	13	14	15	16	17	17	17	19	21	23	23	24
55	14	15	16	16	18	18	19	20	22	24	24	26
50	14	15	16	17	18	19	19	20	24	25	25	27
45	15	16	17	18	20	20	21	22	25	26	27	28
40	15	16	18	19	20	21	22	23	26	28	29	30
35	16	17	19	20	22	22	24	25	27	29	30	32
30	16	18	20	22	24	23	25	27	30	32	32	34
25	17	19	21	24	25	25	27	30	32	34	34	36
20	18	20	23	26	28	28	31	33	35	37	37	40
15	19	22	25	29	31	31	35	39	39	42	42	42
10	22	25	30	34	35	36	40	43	42	48	46	46
5	26	28	36	40	41	42	48	51	52	56	57	58

[a]The norms for age 17 may be used for age 18.
[b]Based on data from Johnston, F. E., D. V. Hamill, and S. Lemeshow. (1) *Skinfold Thickness of Children 6-11 Years* (Series II, No. 120, 1972), and (2) *Skinfold Thickness of Youth 12-17 Years* (Series II, No. 132, 1974). U.S. National Center for Health Statistics, U.S. Department of HEW, Washington, DC[14]

Estimates of Body Fat Content From Anthropometric Dimensions

Unfortunately, procedures are available which encourage the uninformed practitioner to predict the fat content of children from anthropometric dimensions. Caution should be exercised in this regard because of change in fat-free body composition during growth and development and change in the relation of skinfolds to body density.

Projections as to the magnitude of errors likely to occur need further work. Some investigators have calculated the fat content in children by assuming that chemical maturity has been reached. Parizkova, for example, developed regression equations between skinfolds and density in both boys and girls.[12] By using the median skinfolds (triceps and subscapular) in the National Health Survey, the following density and predicted fat content can be computed (Tables 3 and 4). The fat content is calculated from Siri's equation[2] where fat % = 495/body density − 450. For boys (Table 3) the median fat content varies from 17 to 20%, depending on age. Several investigators have found similar values based on body density. All of these estimates may overstate the actual fat content if the fat-free

Table 3. Body Density and Fatness in Male Youth Estimated from Skinfolds Using the Equations of Parizkova[11] and Durnin and Womersley[7]

	Age									
Males	6	7	8	9	10	11	12	13	14	15
Predicted Density[1]	1.060	1.060	1.056	1.052	1.052	1.050	1.053	1.057	1.060	1.060
% Fat[2]	17.0	17.0	18.7	20.5	20.5	21.4	20.1	18.3	17.0	17.0
Predicted Density[3]	1.078	1.078	1.076	1.074	1.074	1.070	1.072	1.072	1.074	1.074
% Fat[2]	9.0	9.0	10.0	11.0	11.0	12.6	11.8	11.8	11.0	11.0

[1]Parizkova[11] Density = 1.108 − .027 log triceps − .039 log subsc.; density = 1.130 − .055 log triceps − .026 log subscapular; 13 to 18 year olds.
[2]Body fatness (%) = 495/body density − 450.
[3]Durnin and Wormersly[7] Density = 1.1525 − .0687 log (sum of 2 skinfolds), 20-29 year old men.

Table 4. Body Density and Fatness in Female Youth Estimated from Skinfolds Using the Equation of Parizkova[11] and Durnin and Wormersley[7]

	Body Fatness									
	Age									
Females	6	7	8	9	10	11	12	13	14	15
Predicted density[1]	1.050	1.049	1.046	1.045	1.045	1.042	1.042	1.043	1.038	1.036
% Fat[2]	21.4	21.9	23.2	23.7	23.7	25.0	25.0	24.6	26.9	27.8
Predicted Density[3]	1.065	1.063	1.060	1.058	1.056	1.054	1.054	1.052	1.044	1.044
% Fat[2]	14.8	15.8	16.8	17.8	18.7	19.6	19.6	20.4	23.9	23.9

[1]Parizkova[11] Density = 1.088 − .014 log (triceps) − .036 log (subsc.), 9 to 12 year olds; Density = 1.114 − .031 log (tricep) − .041 log (subsc), 13 to 16 year olds.
[2]Body fatness = 4.95/density − 4.50.
[3]Durnin and Wormersley[7] Y = 1.1582 − .0813 log (sum of 2 skinfolds), 20-29 year old women.

body density in boys is less than 1.10 gm/cc.

Another approach is to extrapolate from adult equations for prediction of body density from anthropometry. For example, one can predict the density of children from the same two skinfold sites mentioned by using the equations of Durnin and Wormersley[7] formulated for 20 to 29 year old adults (Tables 3 and 4). Using these equations and the median skinfolds from the National Health Survey, the fat content varies from 9 to 12% in boys (Table 3). These approaches appear to underestimate the median fat content of boys which further research will probably show to lie between 13 and 17%. For girls, a similar discrepancy is found between the two approaches, although the magnitude of the difference is somewhat less. This smaller discrepancy is consistent with the smaller changes in fat-free body composition that take place in girls during puberty.

Present methodology leads to the conclusion that the mean fat content of children appears to be between 10 and 20%. Limited knowledge of the changes in fat-free body composition during growth and development prevents more accurate estimates from laboratory methods. Field methods involving anthropometry and data obtained from a large sample of children as part of the National Health Survey can be used to indicate either a relatively low or high fat content. Future research should enable the development of norms for body fatness and the conversion of anthropometric dimensions to body fat content.

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FLEXIBILITY

a major component of physical fitness

By Charles B. Corbin and Larry Noble

Flexibility has long been considered an important component of physical fitness and good health. Interest in the study of flexibility increased in the early 1900s partly because of the increased number of orthopedic cases resulting from World War I and partly because of the epidemic of polio at the start of the century. Though techniques for measuring flexibility have improved dramatically since the turn of the century, interest in flexibility has been sporadic. Cureton and a few other fitness pioneers continued to research flexibility through the 1930s and 1940s but it was not until the late 1950s that public attention again focused on flexibility as an important fitness and health concern.

It was at this time that *Sports Illustrated* magazine labeled a research paper published by Kraus and colleagues, "The Report that Shocked the President." The report indicated that large numbers of American children were unable to perform simple muscular strength and flexibility tasks. Though the test used, the Kraus-Weber test, has drawn much criticism over the years since the original reports, the research by Kraus and others did rejuvenate an interest in flexibility testing, especially among children, and was largely responsible for the development of the President's Council on Youth Fitness, now the President's Council on Physical Fitness and Sport.

In spite of the interest created by the Kraus-Weber test results of the 1950s, flexibility items were not included in the AAHPERD test batteries which were endorsed by the President's Council and which were used as a basis for national youth fitness awards. It has only been in the last few years that interest has been generated for including a flexibility item in the fitness battery. The new test battery includes such an item. The reasons for the inclusion of a flexibility test in the new fitness test battery and the increased interest in flexibility in recent years are many. Flexibility is now recognized by most physical educators and exercise experts as an important component of health related fitness. Kraus and colleagues' early work has helped us recognize the importance of flexibility to such good health practices as proper care of the back and good posture. Fleischman's factor analytic work in the 1960s also clearly established the existence of flexibility as a specific component (or group of components) of fitness.

Not to be discounted is de Vries' work which pointed out the value of passive stretch in developing flexibility and reducing muscle soreness. de Vries' research has been widely cited and at least one current author indicated with the title of his article, "Flexibility: Day of the Static Stretch,"[1] that flexibility and static stretch is the "in thing" among those who exercise regularly. In fact it is difficult to find current articles on fitness which do not expound on the importance of doing regular flexibility exercises. Among those particularly extolling the virtue of flexibility exercises are physical educators, coaches, referees, athletic trainers, and medical doctors. Professional as well as collegiate and scholastic athletic teams now endorse regular flexibility programs, not so many years ago thought to be unimportant. Not to be overlooked are those associated with the jogging-running boom. Jogging-running enthusiasts and authors in the magazines of the movement have pointed out the values of stretching exercises and warm ups for all those who participate.

The interest in flexibility is encouraging to exercise scientists; however, as with any topic deserving of our interest, periodic review of the "state of the facts" seems in order. The following information is based on a review of current research on flexibility. Because of the interest in flexibility, especially among lay people, it is important that we, the practitioners in our field, be aware of the facts so that we can effectively perform our functions as exercise, fitness, and human movement experts.

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The Nature of Flexibility

Considerable research has been conducted concerning the nature of flexibility in recent years and there is some inconsistency of results. In some areas it is impossible to make generalizations about the research findings. However, there is one thing about which there is almost unanimous agreement. Flexibility is specific! Flexibility, though correctly identified as a health related component of fitness, is not *one thing, it is many things*. For operational purposes flexibility is defined as, "The range of joint motion available in a joint or group of joints, mobility."[2] The amount of range of motion is specific to each joint. Range of motion in the shoulder does not ensure range of motion in the hip. In fact, range of motion in one shoulder may not be highly related to range of motion in the other shoulder.

The use of freedom to move as a definition is reinforced by the classic studies of Fleischman which identified specific *static* and *dynamic* components of flexibility. Simply put, static or passive flexibility is the ability to move through a range of motion with no emphasis on speed. To slowly bend and touch the floor, even with assistance demonstrates static flexibility. Fleischman's dynamic flexibility is the ability to use a range of joint movement in the performance of a physical activity at its normal, or at a rapid rate of speed. For example, in gymnastics the "splits" may be done in the midst of a routine of several other important movements. To be able to perform the movement slowly or with an assist is irrelevant. For most sports and physical activities the specific factors of dynamic flexibility are most relevant. Dynamic flexibility truly represents "freedom to move."

It should now be noted that in addition to being specific to each joint and to dynamic and static components, there is also some degree of within joint and around joint specificity. The range of motion or freedom of movement of a joint is influenced by many things. While the actual structure of the joint is important (i.e., knees are designed to flex

and extend but not hyperextend), within the "expected" or normal range of motion for that joint, other factors are more important in determining flexibility. Though studies are not uniform in their findings, it is generally agreed that muscles and ligaments are most important in determining flexibility while tendons are considerably less important. For this reason it can be seen that the elasticity of muscle and connective tissue, particularly ligaments, is especially important to flexibility.

Within or around joint specificity depends on how flexibility is measured. There is evidence that when only single dimensional measurements are made a joint may be considered quite flexible yet when rotational, torque, or two/three dimensional measurements are made, quite different results may be obtained. Clearly, the status of the muscle-connective tissue support to the joint and elasticity of the muscles and connective tissues affecting the movement of the joint are associated with the specificity of within/around joint flexibility. Because elasticity and extensibility of muscle and connective tissue are important to range of joint movement, length of muscle and connective tissue will be considered in this paper as an alternate definition of flexibility. Thus, either range of joint movement or length of muscle/connective tissue will be used in discussing flexibility. However, emphasis in this paper will be on one and two plane movements rather than on joint torque and three plane movements.

The body of knowledge concerning flexibility has increased since the early 1900s largely because of the shift from subjective to more objective measurement techniques. Among the devices currently used to measure flexibility are simple tape measures, rulers, and calipers. More sophisticated measurement devices include arthrometers, instruments for measuring joints; fleximeters, instruments for measuring degree of bending; and goniometers, for measuring angles. The most simple is a protractor modified to be an arthrometer, perhaps the most often used is the flexometer developed by Leighton. More complex are the goniometers which are electric (electrogoniometers), photographic (photogoniometers), and radio (radiogoniometers). There is evidence to indicate that flexibility may be specific to the way it is measured. This may account for the lack of agreement in some areas concerning flexibility.

In addition to considering the need to test specific body parts in measuring flexibility, the practitioner would be wise to consider two simple guidelines when testing flexibility or teaching people to test their own flexibility. For determining improvement in flexibility, intraindividual comparisons may be used. That is, a person is tested several times on a specific test but results are only for self comparison—not for comparison to others. Compound flexibility measures such as the sit and reach test, which involve more than one joint, are acceptable for these comparisons. However, for interindividual comparisons more direct tests such as single joint measures are encouraged.

Why Is Flexibility Important?

The high level of current interest in flexibility is exemplified by the increasing prevalence of stretching programs among athletes and among adult Americans who exercise for enjoyment or health and fitness. Kraus and Raab and other authors interested in the prevention and care of the back have shown that there is good theoretical and clinical evidence to indicate that many back problems are associated with too short or too weak muscles. In fact it was the high incidence of musculoskeletal problems among adults which prompted the testing of youth with the Kraus-Weber test (a test originating from a battery to screen for back problems) in the 1950s. Also, problems with posture can be linked to muscle imbalance and lack of flexibility. The relationships between back problems, poor posture, and lack of flexibility coupled with the fact that muscle soreness, including dysmenorrhea, may be more prevalent among those who lack flexibility establishes flexibility as an important and complex component of health related fitness. Further, flexibility is said by many to be useful in improving sports performance, in reducing muscle injury, and relieving some forms of muscle soreness. Each of these claims for the beneficial effects of flexibility will be examined in the following pages of this paper.

General Information About Flexibility

Before examining the validity of the claims concerning flexibility and health, flexibility and performance, and flexibility and muscle injury, a synthesis of the general research information seems in order. Included is a brief discussion of flexibility and strength training. The observations made in this section are generalizations resulting from an extensive review of specific research studies. It is recognized that, given the specific nature of flexibility, such generalizations can be dangerous. Nevertheless the generalizations seem warranted.

Age. There is contradictory evidence concerning age and flexibility. Given all the research reviewed, it seems fair to say that young children are quite flexible. During the school years flexibility increases until early adolescence when a leveling off or decrease begins. When evaluating the flexibility of children and adolescents, growth (especially individual differences in growth rates) should be considered. Though older adults have less flexibility than younger individuals, there is evidence that even senior adults benefit from flexibility training. With proper training, and barring disease, dramatic increases are not necessary with age.

Sex. There is also conflicting evidence concerning the relationship between flexibility and the sex of the subject. However, a synthesis of the evidence suggests that as a general rule girls may be more flexible than boys. Though scientific evidence is limited, several authors suggest the flexibility advantage to females may persist throughout life. In the absence of empirical data it seems fair to conclude that anatomical differences and/or regular activity differences between the sexes may account for the flexibility differences which may exist between the sexes.

Body Build. There are a few studies which indicate that slight positive relationships exist between various body proportion measures and flexibility measures. However, in total, the evidence leads one to conclude that body build has little practical effect on flexibility. Length of body parts, including height, does not seem to significantly affect flexibility.

Strength Training. Most researchers agree on this point. With proper training, including weight training, in which the exercise is performed through the full range of movement, "muscle boundness" or diminished flexibility need not result. Weight trainers and body builders who do both regular strengthening and lengthening exercises have been shown to have flexibility equal to or greater than the normal population.

Flexibility and Good Health

As mentioned earlier, one of the important claims for flexibility as a physical fitness component is that possession of this fitness factor relates to good health. The ways in which flexibility is said to contribute to good health are discussed below.

Care of the Back. It can be documented that one of the most prevalent medical complaints in our country is low back pain. Statistics accumulated in medical centers indicate that many, if not most, back problems result from weak or inflexible muscles. The prescription for such problems is a lengthening-strengthening program for the muscles and connective tissue. Though much of the evidence is theoretical or clinical, most experts agree that in addition to strengthening the abdominal and back muscles, a flexibility program for lengthening the iliopsoas, lower back, and hamstring muscles is important for sound care of the back. Conversely, there are those who believe that excessive strengthening of the iliopsoas, or lengthening of the abdominals is counter-productive to good back care.

Posture. The evidence concerning flexibility and good posture is similar to that concerning good care of the back; it is largely theoretical and clinical. Nevertheless, most

authorities agree that imbalance in muscular development and lack of flexibility in certain muscle groups are contributing factors to poor posture. For example, poor flexibility in the front chest area and lack of muscular endurance in the shoulder girdle adductors are thought to be associated with rounded shoulders.

Muscle Soreness and Muscle Injury. Another of the health benefits alleged to result from developing specific types of flexibilities is decreased muscle soreness. Those who jog and exercise, including athletes of all types, are now encouraged to do regular flexibility exercises before and after exercise to reduce muscle soreness and muscle injury.

Research results appear to uniformly support the beneficial role of passive stretching exercises in reducing and sometimes eliminating muscle soreness, although there is disagreement as to the physiological explanation of soreness, particularly delayed localized soreness (muscle spasms vs. irritation of the connective tissues). Regardless of the theoretical reasons for it, passive stretching appears to reduce acute muscle soreness immediately following exercise and may be similarly effective in relieving pain of delayed localized soreness.

It should be noted that there is support for the notion that some cases of dysmenorrhea (painful menstruation) can be prevented or at least reduced in severity through regular stretching of the muscles and connective tissue in the pelvic area. Two flexibility exercises most often recommended are Mosher's and Billig's exercise. The basic findings of de Vries' work provides a theoretical foundation to explain the reason for the effectiveness of these and other exercises for those who have pain which is *not* associated with a pathology.

Flexibility and Performance

Of great concern is the question, "Does flexibility improve performance in sport and physical activity?" With the recent focus of attention on flexibility there have been many claims made for the importance of flexibility to improved performance. It must be said that some of these claims may have generalized beyond the facts. To sort out the claims from the facts, the following topics will be explored: (1) the flexibility characteristics of athletics, (2) flexibility and specific performance components, (3) flexibility and activities emphasizing qualitative performance, (4) flexibility and activities requiring extensive joint mobility, and (5) flexibility and other activities.

Flexibility Characteristics of Athletes. Just as flexibility is a specific characteristic, each sport has unique characteristics and imposes unique demands on participants. Even within each sport there are specific requirements for athletes playing different positions. For this reason it is difficult to generalize about the flexibility characteristics of athletes. However, a synthesis of the reasearch does support the notion that athletes who participate in sports tend to have patterns of flexibility unique to their sport of involvement. Baseball and track athletes in general excel in many, but not all flexibility measures. Weight lifters and gymnasts also do well on many flexibility tests but different ones from the baseball and track athletes. Wrestlers are least flexible of all athletes. There is some indication that weight lifters, gymnasts, and wrestlers exhibit least flexibility around joints used for support in their various events (i.e., wrists of gymnasts). Swimmers have been shown to excel on many measures of flexibility.

While the evidence does show that sports participants may have predictable flexible characteristics, the correlational nature of the data does not allow us to establish cause and effect. It is not known for sure whether people develop these flexibility characteristics as a result of the activity or choose the activity because they possess these unique characteristics.

Flexibility and Specific Performance Components. Much of the research concerning flexibility and performance has been laboratory research. In such studies performance components thought to be important to the performance of various sports and activities have been isolated. This is done so that well-controlled research can be done on one specific component and other extraneous factors can be eliminated or controlled. Research findings to date suggest that specific types of flexibility can enhance performance of the long jump, agility as measured by an obstacle run (though one study disagrees), sprint time, ball throwing for distance, and ball hitting. To the extent that these *identical* performance components are important to a given sport or physical activity, possession of a specific flexibility type can enhance performance.

Flexibility and Activities Emphasizing Qualitative Performance. Activities emphasizing qualitative performances are operationally defined here as those such as gymnastics, diving, ice-skating, and dance. In these sports and activities the emphasis is on aesthetic judgments of the quality of the performance rather than on the quantity of performance (i.e., how far or how fast). Though research has indicated that gymnastics performance could not be predicted from flexibility test results among varsity gymnasts, this does not mean that flexibility is not important to gymnastics performance. It is not difficult to see that specific flexibility components are necessary for performances of different kinds and that if all gymnasts have at least the minimal amounts of flexibility necessary to perform the event, additional flexibility may not enhance performance.

Scientific evidence and statistics are not necessary to verify that activities emphasizing qualitative performance often require a significant degree of flexibility to ensure success. Clearly, a ballet dancer who cannot lift his/her foot to the barre is not going to excel, neither is a diver who cannot point his/her toes or a gymnast who cannot assume a pike position. There is little doubt that for these and other "qualitative" activities flexibility is important to performance.

Flexibility and Activities Requiring Extensive Joint Mobility. To be sure, the categories used here are somewhat arbitrary. All sports and activities possess some "qualitative" components (see previous section) and all sports require some joint mobility. Clearly, those considered as emphasizing qualitative performance also require extensive joint mobility. Examples of activities classified as requiring extensive joint mobility are swimming, fencing, and track and field.

More research is available on swimming than on any other sport. As early as 1930 Cureton conducted studies concerning the flexibility of swimmers. We can now say that swimmers possess better flexibility on many measures than normal people. Further, there is indication that those with good ankle flexibility may perform the flutter kick more effectively than those who have lesser mobility of that joint. Whether this provides better propulsion or merely better stability in the water, most agree that it would enhance performance. On the basis of other research it has been suggested that good shoulder flexibility enhances stroke efficiency, and that the superior trunk flexion of swimmers may contribute to more effective performances.

Evidence is lacking concerning other sports classified as requiring extensive joint mobility. Research with joggers showed no greater performances among the more flexible than those who were less flexible. However, the lack of evidence does not mean that flexibility is not necessary for these activities—only that in most instances it is not a limiting factor. On observation alone it can be verified that some flexibility is required for activities in this category. For example, a hurdler cannot perform well without some flexibility nor can a fencer thrust effectively with a limited range of joint movement.

Flexibility and Other Activities. No matter what activities you include in the categories previously listed, there are sports and activities which do not fall in either of the two already considered. A few of the other sports not included are team sports such as football, basketball, baseball and volleyball. For most of these sports, evidence relating flexibility and performance capabilities is lacking. Evidence is available which indicates that both basketball and football players are lower than

normal on several flexibility components and wrestlers and combative sport participants are particularly low in flexibility when compared to other athletes. High flexibility did not improve speed skating performance, although, as already mentioned, it may enhance throwing and hitting ability in baseball. Obviously, more research on flexibility and performance in these sports is necessary.

Flexibility and Performance: A Summary. At this point it can be said, based on scientific evidence, that some performance components can be enhanced by increasing flexibility. Further, there are isolated studies which show that certain activities may require special amounts of flexibility. Also, data indicate that athletes in given sports tend to possess specific flexibility profiles. Couple this scientific information with what we know to be true about various sports and physical activities and it is clear that flexibility can and does affect physical performance. What is not clear is just how much flexibility is necessary for optimal performance in a given activity. Two generalizations on this point seem warranted. First, it is evident that for most activities and sports there is at least a certain minimum or threshold amount of flexibility necessary for effective performance. The exact minimum or threshold level necessary is probably specific to each sport. It may be that flexibility in excess of threshold levels does not enhance performance.

Even in gymnastics, an activity obviously requiring considerable minimal amounts of flexibility, exceptionally high levels of flexibility do not seem to enhance performance. Second, it should be pointed out that unique patterns of flexibility for athletes in a given sport may be a result of participation in the activity. Though cause and effect has not definitively been shown, Clarke[3] on the basis of existing data has generalized ". . . that extensive and prolonged participation in different physical activities or kinds of performances *produces* unique patterns of flexibility."

Flexibility and Sports Injuries

Performance improvement is not the only benefit claimed for those who possess good flexibility. Literally hundreds of books, periodicals, and newspaper accounts are available extolling the value of flexibility training in preventing muscle injury. In 1941 Cureton reported the importance of flexibility in preventing muscle injury. Since then any number of ideas have been presented to establish the importance of flexibility in preventing joint, muscle, and connective tissue injuries. Most common is the notion that muscles which are too short are susceptible to overstretch, particularly in vigorous activity, and thus are predisposed to injury. A shortened muscle is apparently much more likely to exceed its normal range of extensibility than one which has been lengthened through training. The logic of this point of view makes it attractive to the practitioner, yet conclusive data are still not available to document whether lack of flexibility predisposes one to injury and, if so, the minimal amount of flexibility necessary to prevent such injuries. Studies show a high rate of leg and foot injuries among those just beginning a jogging program, as opposed to lower injury rates among more persistent exercisers. Also, studies show a lessening of ski injuries since the advent of preparatory exercise programs including flexibility training. These results lend support to flexibility/injury claims. Among women athletes, more than 50% of all injuries are sprains and strains which most frequently occur in the legs and feet. These data also might lead one to believe that improved training programs, including regular stretching, might reduce injury rates. These bits of evidence are indirect at best. Clear and comprehensive longitudinal data must be collected if we are to answer questions about flexibility and muscle injury.

Another point of view which relates to sports injuries and flexibility states that too much flexibility or range of joint movement can be as dangerous as an inadequate amount. This point of view suggests that too much flexibility may make a joint unstable, for example as in a "loose knee." Those supporting this point of view suggest that both lengthening and strengthening are important, but lengthening the wrong connective tissue or overlengthening the wrong muscles is contraindicated. There is support for this point of view among those in the sports medicine field (i.e., effect of exercise such as the duck walk and deep squat on knee joint stability), but data as to the exact amount of lengthening or strengthening for each specific joint other than the knee are not available.

In summary, there is a wealth of *clinical* support for the need for doing flexibility training to prevent muscle and connective tissue injuries, particularly in the legs, ankles, feet, shoulders, arms, and hip. The conventional wisdom suggests that shortness of muscle and connective tissue which limits joint mobility may predispose that muscle or connective tissue to injury. Also, there is a general belief that too much flexibility in a joint without sufficient stability may predispose the joint to injury. Though a wealth of empirical data on the subject is lacking, common sense suggests that adherence to lengthening-strengthening programs for athletes, vocational or avocational, would be wise.

Developing Flexibility

Just as the concept of the specificity of flexibility is one area of consensus, there is also general agreement among researchers that flexibility can be improved with regular flexibility training. While there is some disagreement as to which technique is most effective in developing flexibility, it is clear that whatever technique is used, the muscle and/or connective tissue which is to be lengthened must be stretched beyond its normal length to be effective. This is an application of the overload principle. Some suggest that the muscle must be "overstretched" by approximately 10%, but no more than that. Others suggest that pain is the key. These people suggest that the muscle should be stretched until it hurts. Neither formula is well documented, though each has been used by practitioners in flexibility programs. This "pain" formula may be ineffective for use with active stretching procedures.

Static vs. Active Stretching. One of the more controversial topics among exercise scientists is the relative value of static vs. active stretching programs for developing flexibility. Static stretch, also known as passive or slow stretching, refers to ". . . slow, sustained stretching exercises, that place a muscle in a lengthened position and hold that position for a few seconds."[2] (One study suggests the muscle or connective tissues must be stretched and held for at least six seconds. Most programs recommend stretching for six to twelve seconds several times daily.) Static stretch may be done with or without the help of gravity or some outside force to produce overstretch such as pressure applied by another person. Active stretch, also known as dynamic, ballistic, bobbing, bouncing, or fast stretching, refers to ". . . a type of stretching exercise involving a bouncing or jerking to gain momentum in the body part to enhance overstretching."[2] Like static stretching the assistance of another person may be used to produce the force to overstretch the muscle or connective tissue.

There is a considerable amount of research which indicates that *both* methods are effective in developing flexibility. There has been no consistent evidence to show one technique to be superior to the other. In view of the apparent similarity of the effectiveness, most authorities suggest static stretching, especially for beginners and those who are not training for high level competition. Since most sports are ballistic in nature, active stretch may be quite appropriate for athletes. However, most experts recommend that a period of static stretch precede active stretching. The tendency of practitioners to favor static stretching is based principally on de Vries' research. That is, static stretch is less likely to evoke the stretch reflex and is therefore less likely to precipitate muscle soreness. Further, some suggest that there is less danger of accidently overstretching a muscle using static stretch. Based on the available evidence, the use of static stretch appears to be

sound practice for most people.

Proprioceptive Neuromuscular Facilitation. This technique, commonly referred to as PNF, was originated at the Kabat-Kaiser Institute as a physical therapy procedure for the rehabilitation of paralytic patients. Since its origin, the procedure, which requires the performer to sequentially contract the muscle to be stretched, then contract the antagonist while stretching the desired muscle, has been used with nonpathological populations. Those who endorse the procedure suggest that PNF, because of the myotatic reflex, reciprocal innervation, inhibitory impulses from the Golgi tendon organ, and resultant muscle relaxation, enhances the benefits of static muscle lengthening exercises. Thus, the procedure is basically a modification of static stretching. One problem in trying to determine its effectiveness has been the wide variation of PNF procedures used in conducting research. The early literature relating the use of PNF emphasized the need for working the muscle at diagonal patterns, while procedures cited in the literature rarely indicate the use of the diagonal method. Further, one author recommends the use of a passive assist while another does not. One suggests several isometric contractions of the agonist (muscle to be stretched) while another uses only one. Because of differences in procedures used in studies comparing PNF, the results of these studies should be viewed with caution. However, results do seem to indicate that whatever the procedure used, PNF is as effective as static and active stretching procedures. At least one study has been reported in the recent literature which indicates a form of PNF to be superior to either static or active stretching. Additional research is necessary.

The Flexibility Warm-Up

Just as exercise enthusiasts and practitioners attest to the importance of regular flexibility training, most are also convinced of the value of a flexibility or stretch warm-up. Joggers, for example, have developed a specific set of stretching exercises to be used as a warm-up. Before examining the value of such a warm-up, the difference between a flexibility training program and a flexibility warm-up should be clarified. A flexibility training program consists of static, active, or PNF exercises included in a regular program designed to improve flexibility over a long period of time. On the other hand, a flexibility warm-up is a group of exercises done immediately before an activity designed to improve performance or to reduce the chances of injury in that activity. The evidence supports the fact that chronic training can produce flexibility gains, but what of the warm-up?

Research has shown that passive stretching just before a trunk flexion test can result in improved performance on the flexibility test. Nonetheless, it should be noted that there is no evidence that a "one time only" warm-up can replace a regular exercise program for developing flexibility.

Some have suggested that flexibility can be improved by passive warm-up techniques which increase muscle temperature. Physiologists generally agree that the elasticity of muscle and connective tissue is affected by temperature. While the limited research available suggests that warming the muscle via a hot shower may produce some improvement in test performance, the benefits are not equal to those resulting from stretching exercises, and cannot be considered as permanent gains in flexibility.

Concluding Points of View

Regular training can result in flexibility improvements as determined by joint mobility and associated length of muscle and connective tissues. There are several effective techniques for developing flexibility. Of these techniques, the available research and good common sense suggest that static or passive procedures are best for most people. For those involved in vigorous sports, because they require dynamic movements, active stretching is effective and appropriate. Above all, it is clear that flexibility is specific to each joint and probably is specific in other ways as well. A person cannot be deemed flexible on the basis of one test or even on the basis of a limited battery of tests.

These writers also conclude that until additional evidence is produced to show otherwise, persons who expect to participate in regular activity would be wise to establish a regular flexibility program and to do stretching exercises before and after exercise. How much flexibility the person should develop is open to question but at least minimal levels seem necessary to optimal performance and prevention of injury. Those involved in sports and activities involving a high degree of injury would do well to strengthen as well as lengthen muscles around vulnerable joints. It is possible that too much flexibility may result in joint instability and susceptibility to injury.

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Medical Problems Encountered by Women in Aerobic Exercise

Dorothy V. Harris

While females are generally 5 inches shorter, 30 to 40 pounds lighter, and 10 percent fatter on the average than males, they respond and adapt to chronic exercise and physical training much as do males. Efforts to determine the quantitative and qualitative differences in response to physical training of males and females have generally demonstrated that observed differences are not mediated by sex but by physical fitness. In short, the differences are influenced more by factors other than biological sex. More differences exist within a sex than between the sexes when fitness levels are controlled.

In spite of the fact that the female does respond to exercise in much the same pattern as the male, she performs at a substantially lower level in almost all athletic contests. In running events (based on 1977 records) the percentage of differences in performance was 9.62 in the 100 meters, 11.02 in the 400 meters, 13.0 in the 1,000 meters, 15.3 in the 2,000 meters, 18.15 in the 10,000 meters, and 17.0 in the marathon. Are these differences truly biological ones, are they only the result of sex differences, or are they reflective of social and cultural restrictions and expectations placed on the female?

Smaller, slower, weaker persons are discriminated against in selection for sports participation. Only about 20 percent of the body types are represented in the Olympics. Generally, there is less difference in the body types of males and females who excel in the same athletic events than there is between males and females in general or perhaps between males who are selected and males who are not. In other words, the high jumper, male or female, who uses the Fosbury flop will be quite similar in body type. Much the same can be said about the basketball player, the marathoner, and so on.

The female matures sooner than the male; 20 weeks after conception she is 2 to 3 weeks more mature and at birth she may be as much as 20 weeks ahead of the male's maturation. This is owing to the fact that the male must wait for "something to be added" or the Y chromosome to indicate that the gonads will be testicles. These cells must mature and multiply sufficiently to begin to produce androgen or the male hormone that will then begin to differentiate to male development. This lag behind the female in development is not closed until the male reaches age 20. Great variation exists in the maturation rate with this being more obvious in the male. Seefeldt (1978) reported as much as 40 months' difference in maturation among 6-year-old boys and 72 months' difference in 13-year-old boys. Wide variation does not prevail among females, most of whom have reached their mature height and growth soon after the onset of menarche. One cannot recruit a girl from high school for basketball and assume that she will grow several more inches while in college. Most males, however, will continue to grow during those years.

During late childhood the female may be bigger than her same aged male peer because of reaching her growth spurt sooner. During this time she may be faster and stronger and outperform boys in athletic feats provided she has had the opportunity to learn skills and has been reinforced in a positive manner for her performance and involvement. Once physical maturity has been reached, there are average differences between males and females that have specific implications for athletic performance.

Males, because they mature later, therefore grow longer and are generally bigger than females. The higher levels of androgens (male hormones) also influence development. Males have longer trunk length, broader shoulders, greater muscle development in the shoulder area, and less body fat. Higher estrogen levels (female hormones) in the female close off the epiphyses of the long bones sooner, resulting in lesser height. Body fat is increased with the female being 10 percent fatter than the male. Her hips are broader in relation to her shoulders, she has less muscle mass in the shoulder girdle, and tends to have a longer trunk in relation to length of leg. Body type is also influenced by genetics, nutrition, exercise, and other factors beyond those of the endocrine system.

As indicated, there are average differences between males and females that have specific implications for sport performance. Wilmore and Brown (1974) examined 78 female distance runners and found that 12 had less than 10 percent body fat, 32 less than 15 percent or under that of the average college male. These trained women were significantly less fat than their untrained female peers who have approximately 25 percent body fat. While low body fat may be a genetic endowment, high-intensity endurance-type exercise is also a significant factor. It appears that females can approach relative fat values of male athletes with strenuous training. It also appears that the average fat values of untrained females are higher than ideal; regular exercise could reduce those stores.

A greater percent of body fat in the female provides her with advantages for some activities. She is more buoyant in water and has better insulation in cold temperatures. This combined advantage has enabled females to better the world records in distance open-water swimming. A young Canadian woman swam the English Channel round trip in the fall of

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1977 and knocked more than 10 hours off the male record. Ullyot (1976) said that women "run off their fat," that the additional fat that women have provides them with extra fuel for energy. Women may be able to use their fat stores more efficiently than males. It is possible that they burn a higher percentage of fat mixed with glycogen, thus glycogen lasts longer and females feel better after running a marathon than do males. While the biochemical mechanisms have not been isolated, there appears to be a difference in the adaptation and coping to strenuous endurance-type exercise between males and females.

Strength differences between males and females have traditionally been acknowledged. However, Wilmore (1977) stated that leg strength is nearly identical in the two sexes. When expressed relative to body size it is identical. In fact, when expressed relative to lean body mass, the females are slightly stronger. The difference between males and females in strength is greatest in the shoulders, somewhat less in the trunk, and appears to be similar in leg strength. The female responds to strength training in much the same manner as the male in terms of percent gained. While resistive weight training produces large gains in strength in the female, concomitant gains in muscle bulk do not result. In the fall of 1977 a 114-pound female broke the males' lift record in that weight class by lifting 225 pounds. There is much to learn about factors relating to strength, strength development, and maximizing one's potential development in strength.

Efforts to determine qualitative and quantitative differences in the aerobic capacity of males and females have demonstrated that the female has a maximal oxygen uptake that is less than that of the male. In general the level of physical fitness overrides the effect of sex. Hermanson and Andersen (1965) reported that female cross-country skiers had an average of 55 ml/kg min while the average male had 44 ml/kg min. Female athletes have higher oxygen-carrying capacity than untrained male peers. While athletic males are noticeably superior, trained females are 25 percent more efficient than untrained males. Body composition and level of training generally explain the observed differences between males and females. Whether the lean body mass of the female can approach that of the male with the same training is a moot point. The female must deliver oxygen to her fat tissue as well as her working muscle as part of her work load; she cannot leave her fat tissue in the locker room.

In addition to body composition and level of training, other factors influence the maximal oxygen uptake. The female generally has a smaller heart, lungs, chest muscles, blood volume, etc. She compensates for these average differences with the ability to increase her heart rate to levels higher than that observed in most males. Another significant difference is observed in the percent hemoglobin with the female having as much as 10 percent less than the male (Harris 1977). No significant differences are observed until puberty between males and females. The assumption has been that the female's hemoglobin is reduced through blood loss with menstruation. However, Lamb (1975) reported a 20 percent increase in hemoglobin in castrated male animals when testosterone was injected and concluded that testosterone promoted red blood cell production. It appears that males significantly increase their hemoglobin as testosterone increases and that females do not necessarily reduce theirs through normal menstruation. However, males have approximately one million more red cells than females and can store 850 mg of iron as compared to the female's 250 mg. Compensatory factors do not appear to adjust for this difference in males and females, therefore, some type of iron supplement is frequently recommended for the female athlete.

Russell Lane reported in *The Jogger* (1978) that sports anemia in endurance exercise *is* a result of a training effect brought on by hypervolemia or increased fluid volume. It has been shown that the iron content of sweat during endurance exercise increases somewhat. The cardiac volume is up, and the red-cell mass changes to a lesser extent than either the volume or heart stroke volume. The important change is the increase in the circulating blood volume with the associated lowered blood viscosity and faster flow. The so-called "anemia" may in fact be beneficial to the athlete in providing more rapid delivery of oxygen. Furthermore, Lane suggested that the process must involve some genetic factor to explain the variable appearance and individual difference in response. In some athletes the process seems to outdo itself and lead to clinical and dysfunctional anemia that some have called "maladaptive" training effect. In summary of the issue, it does seem worthwhile to suggest to aerobic exercisers that low hemoglobin may be a positive factor and not necessarily a negative one. Those persons who appear to be anemic without any symptoms may be members of a select group possessing genetic constitutions to witness this "training effect" in sport rather than needing iron pills for treatment.

Menstruation and factors relating to that process have probably produced more concern and misinformation than any other difference in males and females. Females have made and broken their own personal best performances at all phases of the menstrual cycle. It appears that there is no decrement in performance for females who have made a serious commitment to sport pursuits. However, it is possible that the population is biased toward these women who experienced no impairments. Those who did may have been systematically eliminated.

The 1970s have witnessed an awareness of another pattern of response in females who are training strenuously (Harris 1977; Brozan 1978). Perhaps 15 to 20 percent experience secondary amenorrhea or cessation of menstruation. Several theories attempt to explain this response. The percent body fat is the most often expressed rationale. Ullyot (1976) says that it is Mother Nature's way of protecting the female. Because of reduced body fat, for whatever reasons (starvation, disease, exercise, etc.) the body does not have sufficient fat storage to support a pregnancy so the system "shuts down." Frisch (1974) supports this theory to some extent. She developed a method for predicting age for onset of menarche by charting the height and weight of girls every year during their 9 to 13 age span. She concluded that the ratio of lean body weight to fat is an important determinant of sexual maturation in the female. However, this relationship is not a cause-effect one since increasing levels of estrogen cause the female to begin to store body fat as well as triggering the menstrual cycle. In essence, body fat and menarche are both caused by elevating levels of estrogen, therefore, increased body fat is not the cause of the onset of menarche. They coincide.

In several situations a significant decrease in body fat does appear to be related to secondary amenorrhea. Starvation, anorexia nervosa, and a drastic reduction in caloric intake, resulting in a rapid and significant weight loss, produce secondary amenorrhea. At the same time obesity can also cause cessation of menstruation. Other stressful situations such as being in a concentration camp, entering college, experiencing the loss of a loved one, divorce, fear of failure, etc., can also alter the menstrual cycle.

Since reduction of body fat does not hold in all cases of secondary amenorrhea reported, other explanations have to be explored. Females who are on the same training program, who have no significant differences in percent body fat, and who have not lost a significant amount of body fat can be on the same track team. Some of these women will experience secondary amenorrhea while others will not. Individual differences in response to stress may be the explanation. Why some endure stress without any noticeable changes while others do not seems currently a medical mystery. This may be the case whether that stress is exercise, quick reduction of body fat, emotional stress, competitive stress, or whatever. There is need to examine a whole array of responses to understand why some women experience secondary amenorrhea.

The magnitude of the problem has not actually been established. It appears that several different patterns occur. First, those who have had normal cycles, then experience secondary amenorrhea with an increase in physical training and exercise, generally resume normal cycles with detraining. In many cases persons did not menstruate for 2 or more years, stopped hard training, resumed their cycles, and had normal pregnancies and deliveries of healthy babies.

Second, some women experiencing cessation of menstruation did not alter their training programs or replace the lost fat tissue, yet their cycles reappeared with time. This would suggest that the body adapted to the stresses placed upon it and accommodated them without long-term endocrine alteration. A 1978 survey study completed at Boulder, Colorado, suggests that the percent of those experiencing secondary amenorrhea increases significantly as mileage increases. Running 60 or more miles a week may be the critical factor. At this point no one knows for sure whether exercise per se or low body fat causes the condition. As Dr. John Marshall, cochairman of New York Medical Society's Committee on the Medical Aspects of Sports, said, "The body-fat percentage is not the cause; all kinds of things we don't know about the delicate balance of hormones have an effect. It may have to do with the kind of training, it may be psychological." Certainly, the medical profession does not know.

In response to an article in *WomenSports* (Harris 1977) nearly 200 letters relating case studies were received. I must say that I was dismayed at the medical treatment and guesswork that some women were subjected to, not to mention the almost total disregard of even considering that vigorous exercise had anything to do with their secondary amenorrhea. One woman spent 6 years with different physicians experimenting with various tests and theories. She underwent brain scans, injections of hormones, oral hormone medication, and exploratory surgery. Finally, it was concluded that she was "having identity problems and denying her femininity" since nothing irregular or abnormal appeared beyond the fact that she did not menstruate.

While alterations and changes in the female cycle are obvious, males may have similar alterations and not even know about them. A little-known 1973 Finnish study reported in the 1976 *British Journal of Steroid Biochemistry* involved hormonal assays before and after in males running a marathon. Statistically significant changes were observed in several hormones which impact on male sexuality. A rise or fall in their levels can adversely affect fertility, both in decreasing sex drive and lowering sperm count. Almost no one has examined this relationship. Dr. Mona Shangold, physician-endocrinologist, suggested, "There may be a relationship between reproductive problems and chronic exercise such as extensive training done by long-distance runners." She suggested further that if there is a correlation between very low body fat levels and fertility problems, this may mean that runners of both sexes will have to decrease their running if they wish to have children. For women, until their cycles return; for men, who knows? Shangold suggested that a male with a low sperm count who wished to restore it to normal may have to stop running for 74 days because it takes that long for sperm to mature.

To date there is nothing in the literature to support the belief that there is a high infertility rate among runners, male or female. The problem may be on a very small scale indeed because of great individual differences and responses to exercise and stress. The cardiovascular, psychological, and other benefits of running far outweigh potential adverse effects on reproduction. Further, there is no evidence to suggest that any reproductive problems that develop while training are irreversible.

Another concern about which even less is known is the possibility of strenuous exercise delaying the onset of menarche. The *New York Times* quoted Dr. Jack Wilmore as saying, "We know there is a tendency for girls who participate in heavy competition before menarche to have onset delayed until they are 17 or 18 but we do not know whether that is good or bad." The average age of onset is between 12 and 13 years; however, beginning menstruation at age 15 or 16 is still considered normal. At a discussion of the issue at the American College of Sports Medicine meeting in Chicago in May 1977, physicians could not agree as to the age at which one should become conerned if the female has not begun to menstruate. At this point it is not known whether strenuous training prior to puberty can be detrimental to normal development of the endocrine or reproductive systems. No one knows whether it is possible to delay development and then make up for that delay with a decrease in training routine.

Apparently there is little reason to drastically alter one's exercise pattern with pregnancy if that pattern has been a part of one's life-style for some time. Pregnant athletes have accomplished all sorts of athletic feats during the early stages of their pregnancies. Lynn Blackstone, during her ninth month, ran twice around Central Park's reservoir, which is approximatley 3 miles, each evening. She finished 58th out of 102 women in the 1977 Boston marathon. Mary Jones ran a half-marathon race at the Dallas White Rock Marathon in 2 hours and 5 minutes in December 1976 when she was nearly 9 months pregnant. She returned to marathon running 10 weeks after giving birth saying, "Pregnancy is not a disease. I listened to my body and let it dictate what I could do and I'm healthier for it." Many others report the same experience. Trina Hosmer, U.S. Olympic cross-country skier in 1972, ran 4 miles 2 hours before her first child was born. She barely had time to change and get to the hospital for delivery. While Trina may be exceptional, no evidence exists that regular exercise and running during pregnancy have to be discontinued if the female is used to regular exercise.

Osteoporosis is far more prevalent among women than men; several reasons may account for this. First, growing girls are not generally socialized to participate in vigorous exercise during those years when bones are developing and growing so that stresses placed on them during this time can result in stronger, denser bones. Second, estrogen levels decrease with aging and onset of menopause and the effect that estrogen has in stimulating bone maintenance is lost to some degree. Third, females do not exercise enough throughout their lives to

stimulate bone maintenance. Running, jogging, or other types of regular exercise are especially important for aging women, yet the emphasis has been on males' getting exercise. The harmful effects of inactivity on bone tissue are well documented; long-term bed rest can lead to early osteoporosis. Even bones that are briefly in a plaster cast tend to become lighter because of mineral loss. The astronauts experienced alteration in bone metabolism during periods of weightlessness and physical confinement.

On the other hand, exercise stimulates bone growth and maintenance; one has only to examine one's dominant arm to compare the difference between it and the lesser-used one. Prevention and/or delay of osteoporosis appears to be related to vigorous exercise during the growing years to maximize the skeletal development, then continued exercise throughout one's lifetime with some attention paid to the amount of calcium in the diet.

Females may be more efficient in heat dissipation, or less efficient than the male, depending on how the research is interpreted. Studies show that males do sweat sooner and more profusely than females in response to increased body temperatures. However, males may be prolific wasteful sweaters. The female may adjust her sweat rate more efficiently, that is, she can compensate for the observed differences. On the average, females have more sweat glands than males. Generally, her body temperature gets 2 to 3 degrees warmer than that of the male's before she begins to sweat. Females sweat less than males and can perform the same work loads with less water loss. Both males and females acclimatize to work or exercise in heat; however, females are able to do so without increasing their sweat rates. There may be some explanations that have not been examined. First, higher levels of estrogen in females tend to provide greater vascularization, therefore the female may be able to get more blood to the surface of her body for cooling which would delay the sweating process. This fact may allow her to compensate for her additional fat insulation and smaller body surface. Second, since the female has more active sweat glands than the male, her sweat is distributed more evenly over her body for maximal cooling by evaporation, again compensating for her smaller body surface.

While the male sweats sooner, the female may sweat better. Wells (1977) also suggested that women may regulate their body temperature more effectively than males do from her research in heat environments. Perhaps it is time to examine this response more carefully and stop perpetuating the notion that females may be less effective in heat dissipation. Once the next generation is socialized out of the notion that men sweat, gentlemen perspire, and ladies glow, we may observe a different response to heat stress.

In summary it appears that while the male and female do differ in many respects in terms of their response to vigorous exercise, there are more differences within a sex than between the sexes. The level of physical fitness mediates the difference to a greater extent than sex. Further, when differences are observed in trained males and females, in most cases the response is one of adapting and conditioning to chronic exercise. In many situations the female adapts differently in that she compensates for these differences. Or, we could say that the male compensates, as in the case of his having to sweat sooner in order to cool his body.

When training and conditioning are equal, there appears to be no difference in the injury predisposition between males and females. Statistics suggest that females are more vulnerable to leg and knee injuries. Again, the level of physical conditioning and fitness is more important than one's sex. As increasing emphasis is placed on this for female athletes, the injury statistics are associating more with the type of sport played rather than sex. In short, basketball players will experience similar types and rates of injuries that will not be sex linked. Much research is needed before full understanding and insight into just what differences do exist between the response of males and females to long-term strenuous exercise. Right now it appears that the sauce for the gander is good for the goose. The female gains all the benefits and pleasure of having as healthy fit body as the male and certainly the joys and challenges of sport participation and competition are not sex-linked. From everything available in the literature, the responses are all positive in physiological and psychological ways.

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Psychological Benefits of Aerobic Exercise

Dorothy V. Harris

Exhilaration, euphoria, ecstasy, peak experience getting high, being spacy, or whatever one labels it, the experience is basically the same for those persons who are physically fit and who pursue exercise as an end in itself. They are "tuned in" and "turned on" by exercise. They enjoy the psychological and physiological returns they get from such experiences and return again and again for these sensations. The pure joy of participation in physical activity can only be gained when the activity is viewed as nonpurposeful in a utilitarian sense. The body is not thought of as a machine or object requiring maintenance or something that works independently from the mind or feelings. Nor can exercise be viewed as something the body needs like medicine or a treatment if one wishes to experience all that exercise can offer.

This is not to say that one does not get involved in exercise initially to get into shape, to lose a few pounds, or to counter ill effects of a sedentary life. However, in the process of reaching these initial goals one may discover that other things happen. One person who had just gone through a traumatic divorce and knee surgery had this to say: "I was in a physical and psychological rut. Running seemed a logical way to get my knee back to normal. The unexpected dividend was that I got my head together, too."

Regular participation continues long after the original goals are reached. Persons discover that exercise is fun, that they experience a sense of total integration never reached before. They find that they are tuned into their bodies and discover things about themselves that are reinforcing in a most positive manner. Traditional physical education has been making claims such as these for years; however, little systematic evidence exists to support such an idea. Most of the early research in personality and sport was based on the notion that a "sound body ensured a sound mind." Conceptually, the questions being asked were correct ones; the method and instrumentation frequently prevented the investigator from finding real insight into such a relationship.

When one is out of touch with his body and his feelings, he cannot be a fully functioning, integrated being. As Alexander Lowen said in his book, *Pleasure* (1970):

> Self-awareness is a function of feeling. It is the summation of all body sensations at any one time. Through his self-awareness a person knows who he is. He is aware of what is going on in every part of his body: in other words, he is in touch with himself. For example, he senses the flow of feeling in his body movements. But he is also aware of the muscular tensions that restrict his movement, for these too create sensations . . . Not being in touch with his body from within, it feels strange and awkward to him, which makes him feel self-conscious in his expression and movement.

Exercise and physical activity can provide opportunities to develop self-awareness through the integration of body, mind, and feelings. Becoming aware of what is happening within the body intensifies the experience and increases one's awareness. This awareness provides a type of feedback that produces a sense of mastery, control, and competence that can be reached in no other way.

Deci, in his book published in 1975, deals with human motivation. He presents a cognitive perspective in attempting to account for the "whys" of voluntary behavior. He works under the assumption that most behaviors are voluntary and that persons choose these behaviors because they desire the end result. Therefore, the person's perceptions and cognitions will be basic to his behavior. The operational definition of intrinsic motivation suggests that activities engaged in are ends in themselves as opposed to a means to an end. In other words, intrinsically motivated involvements are ones for which there is no apparent reward except the activity itself. As a result, persons participate in activities for the feedback they get in the process of being involved and not because the involvement leads to an extrinsic reward. Many activities are intrinsically rewarding; persons spend much time playing sports, solving puzzles, practicing skills, and so on because they produce certain types of internal conditions that they find rewarding.

Another basic premise upon which the notion of intrinsic motivation is based is that people tend to be motivated to reduce uncertainty and to feel capable of dealing effectively with the environment. The concept of competence proposed by White (1959), rejects the notion of a drive-reduction theory and emphasizes the importance of the interaction of the person with the environment. His concept of competence refers to one's ability to deal effectively with one's environment through a whole range of behaviors such as exploration, perception, cognition, manipulation, and so on. According to White, the competence motivation or effectance motivation is what directs these behaviors that are motivated by the intrinsic need to cope effectively with the environment. White explained that young children have patterns of undifferentiated effectance motivation. However, with additional experience, behaviors are more differentiated into specific motives for mastery, cognizance or achievement. Ellis (1973)

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indicated in his book that the proposition of White accounted for behavior beyond the arousal-seeking behavior that Ellis had used to explain children's play. That is, White's competence-effectance motive would explain the repetitious behavior that persists after the novelty has worn off; this behavior can be explained as manipulation to produce effects on the environment.

Deci proposed that one's need to feel competent and self-determining will produce two general classes of behavior. First, persons will seek out situations that provide a reasonable challenge; if one is bored, one will seek a challenge, if one is overchallenged, a different situation will be sought that will provide a challenge which can be handled. In essence, this suggests that the motivational mechanism operating will lead persons to situations where they are challenged to make optimal use of their abilities.

The second class of behaviors motivated by the need for competence and self-determination that Deci described were those needs to be successful in challenge situations. That is, persons are motivated to reduce dissonance when they encounter it or create it. Many create dissonance or incongruity just so they can have the challenge of mastering it.

Thrill addicts were once thought to have a death wish or an urge to self-destruction; however, research supports the fact that they are exceptional in their emotional health. Dr. Edward Stainbrook, head of the Human Behavior Department of the University of Southern California, said, "So much of life has become sedentary, inhibiting action. Thrill seeking expresses an almost desperate need for assertive mastery of something. In some cases, the aggressive defiance can be overdone and become a disguised suicidal drive. But more often, it's just a quest for control of self — and for doing, rather than thinking."

"Action is the adolescent antidepressant," said Dr. Gerald Polin, a psychiatrist who has researched this phenomenon. He suggested that thrill sports may be a symptom of the depressed feelings that many adolescents have. Many persons of all ages express a periodic need for extending themselves to absolute physical, emotional, and intellectual limits in order to escape from the routine and boredom of everyday living.

In *Beyond Boredom and Anxiety*, Mihaly Csikszentmihalyi (1975), a psychologist at the University of Chicago, discusses the basis of experiencing enjoyment and fulfillment through activities for which the primary reward is in the experience of the activity rather than other outcomes. In activities of this type the person experiences an altered state of consciousness that he calls "flow" where one is aware of his actions but not aware of his awareness. Concentration is so focused on the process of doing that any thoughts of what one is doing or how one is doing would stop the "flow." In this state the integration of mind, body, and feelings is so focused that "flow" provides a dimension in the activity that cannot be reached intentionally; it just happens.

While athletes have known about these "altered states of consciousness" for some time, they have only recently begun to share their highly personal experiences. It is a nonverbal, almost overwhelming sensation. It can be felt during losing or during noncompetitive moments, too . . . by the parachutists in flight, by the skier, by the runner running alone. Dwight Stones talked about such an experience the day he broke the world high jump record at the Munich Olympics. "The realization of reaching 7-6½ startled me . . . I just lost control. I remember I couldn't wait to hit the pit . . . it seemed like an eternity. . . . The whole thing was so spontaneous, so unplanned. You know certain goals are within reach but you still explode when it comes off . . . it's such a mental climax."

One doesn't have to be an athlete to experience "flow"; continued participation is the key for young and old alike. The opportunity to reach altered states of awareness are created when you forget about gaining any external reward for your efforts. Once exercise is the end, not a means, sensations come through loud and clear and the body feels energetic, alive, tingling, and capable. When the body is "let go" in exercise, almost anything can happen.

Back in the early sixties when jogging was becoming the thing to do among some status groups, its benefits were measured in health and medical terms; one exercised to prevent a heart attack, or to develop a sexier body, or to lose a few extra pounds. However, the benefits were too far removed from the exercise to keep most persons motivated to continue. Those who did persevere discovered that in addition to doing fantastic things for the body, exercise did something for the head as well. From this point on, they no longer exercised for health; they exercised because they felt good. As a matter of fact, there is some evidence to suggest that one can become addicted to exercise, that one feels less well without it and suffers withdrawal effects when it is missed. It is not surprising, then, to have persons feel deprived when they can no longer exercise.

Baekeland (1970) explored sleep and psychological reactions to exercise deprivation. He found it was difficult to recruit subjects who exercised regularly and were willing to give that up for a month or so. Even though they were offered good pay and knew that they would make a contribution to science, they were unwilling to deprive themselves of their regular exercise habits. Many said they would not stop exercising for any amount of money. Baekeland's subjects were persons who exercised three to four times a week. However, they too viewed the anticipated no-exercise period as exercise deprivation rather than as exercise restriction.

The subjects' sleep was studied for two nights several days apart while they were still exercising regularly. The no-exercise period was sampled at intervals of about 2, 7, 14, and 30 days after the last exercise bout. The EEG sleep records were scored for the conventionally defined stages of sleep. REM frequencies were also recorded. A questionnaire evaluated the psychological changes observed near the end of the no-exercise period. The findings reported indicated a change in sleep patterns suggesting increased anxiety over the no-exercise period. The subjects' subjective reports indicated a decrease in the quality of sleep at home, increased sexual tension, and an increased need to be with others.

In a book entitled *Positive Addiction*, Glasser (1976) reported that runners can become positively addicted to the euphoria of running and that this can provide a source of adaptive strength that can be transferred to other areas of life. Glasser indicated that there were six steps one has to follow in order for this positive addiction to take place. The physical activity pursued must be noncompetitive and one chosen voluntarily. It must be an activity that one can do easily, that does not require a great deal of mental effort, and at which one could spend an hour or so a day pursuing. It must be something that can be done alone or with others but not dependent on others. The participant must believe that it has some positive value, either physical, mental, spiritual, or all three. Further, the participant must believe that persistence will be rewarded by improvement. It should be noted, however, that only the participant will be the one to evaluate the improvement. Finally, the activity must be of a type that one can do without criticizing oneself; one must accept the self

at whatever level of performance. Glasser suggested that these are the reasons why running has become so popular with many persons who have never done any other type of regular physical exercise.

Other writers (Andrews 1976) report that there are definite psychological milestones that runners reach in the route to altered states of consciousness or heightened awareness. These milestones have more to do with how long one runs rather than how far one goes. Even the most accomplished and fit runner experiences general discomfort during the first 20 minutes or so and asks himself why he is doing this. After about 30 minutes he begins to feel a mild sort of euphoria. He has worked out the tensions and is being "lulled" by the rhythm of his breathing and running. After about 40 minutes he loses the ability to organize thoughts and ideas flash in and out without any conscious effort. After about an hour of running one reaches an altered state. If running is continued, the runner feels a mystical unity with the surroundings and the Zen of running can really be enjoyed.

Kostrubala (1976), a psychiatrist and a veteran marathoner, says that running is a natural form of psychotherapy. Few people can run and worry at the same time. Kostrubala has trained several of his assistants as "running therapists" and claims some success in using jogging as a treatment for depression, drug addiction, and other psychological problems requiring treatment. He said, "I think this is a new and powerful way of reaching the unconscious."

A British medical team headed by Dr. Malcolm Carruthers reported that running does change the hormones of the body. As little as 10 minutes of endurance exercise can double the body's level of norepinephrine. This neurohormone is associated with alertness, responsiveness, and a high level of mental and physical activity. This tends to reduce depression and anxiety for a period of time (Parker 1978).

Several other investigators support the notion that "action absorbs anxiety," or that exercise is nature's own best tranquilizer. DeVries and Adams (1972) studied 10 patients, 52-70 years old. One day they gave their patients a tranquilizer and the next day had the patients walk vigorously enough to raise their heart rates over 100 beats per minute. The exercise produced a greater calming effect than the tranquilizer with positive rather than negative side effects. The paradox appears to be that one must exercise to relax. Traditionally relaxation has been associated with being sedentary yet all of the scientific evidence suggests just the contrary.

The mystique of jogging, along with the claim to work wonders for the body and soul, has begun to invade the domain of American psychiatry. Many are now prescribing exercise instead of pills for moderate depression. Writer Valerie Andrews, author of the book, *The Psychic Power of Running* (1978), argues that weekend jogging could well be the basis for the nation's first grass-roots movement in community health. UCLA psychiatrist Ronald M. Lawrence says, "Mild depression is more common than the common cold, but it can be markedly helped by slow endurance exercise." He said further, "Man was meant to be a moving animal, but he's become sedentary. Distance running can bring us back to the basics of what we're here for." While hard evidence is lacking, Ismail and Young (1977) observed significant relationships between changes in certain hormone levels of exercises and improvement in emotional stability.

Brown, Ramirez, and Taub (1978) have also produced evidence demonstrating a decrease in depression with exercise. Their first experiment involved 167 high school boys and girls who were participating in a variety of sports. They completed three psychological inventories: Zung Depression Scale, Eysenck's Introversion-Extroversion Scale, and the Human Figure Drawing. In addition they were asked to keep a journal of their physical activity, mood states, and sleep habits.

The second study by Brown, et al., attempted to control more variables and added several more inventories. There were three groups: a no-exercise, one running three times per week, and one running five times per week. Each treatment lasted for 10 weeks. Several outcomes of these two studies were reported: (1) subjects in the exercise group, depressed or not, showed increases in mental well-being, (2) the number of depressed subjects dropped from 37 to 14, (3) psychological scores of the subjects in the nonexercise group did not change. Brown, et al., also found that the amount of exercise was significant; the more vigorous the activity, the more significant the change. No significant difference was observed in those persons participating in sports requiring low levels of physical activity. Brown, a psychiatrist at the University of Virginia, says that he has not observed anyone jogging on the track who ever appeared to be depressed. He finds that exercise works better than pills in controlling depression. Approximately 70 percent of his patients are depressed and all but about 15 to 20 percent show quick benefit after only a week of running.

Folkins, Lynch, and Gardner (1972) have also used physical activity as a treatment for psychological disorders with reported success. They used several adjective checklists to measure variables related to both depression and anxiety. Three college physical education classes formed the experimental and control groups; an archery class and a golf class were used as controls with a jogging class serving as the experimental group. Preliminary testing showed that the two groups differed on the psychological variables; the women in the experimental group were significantly less fit psychologically than the controls. They were more anxious, more depressed, less confident, and less well adjusted. After 15 weeks of running, these females had shown significant improvement in all these areas. The males also improved but not to the same extent. No changes were observed in the controls.

Driscoll (1976) used physical exercise to counter anxiety along with positive imagery and reported success, emphasizing the short time treatment took with exercise. Orwin (1974) used running to overcome phobias and demonstrated that physical exhaustion interfered with anxiety. Using this treatment he found that persons could become conditioned to their fears much more readily after vigorous exercise than without it. He concluded that some sort of physical exercise should be included in all therapies for anxiety.

In the late 1960s and early 1970s Morgan has produced more systematic evidence than any other investigator to date. He has completed a series of studies (Morgan 1967, 1969, 1970; Morgan et al., 1970) and concluded that differences in depressed persons' ability to perform physical tasks were psychological, not physical. In the second phase of one study (Morgan et al., 1970), 101 subjects participated in six weeks of physical activity: circuit training, jogging, swimming, treadmill running, or bicycle ergometry. Through this phase Morgan reported that the depression scores of those subjects in the normal range did not change; however, those persons who were depressed changed significantly at the .01 level.

More recently Morgan (1976; Morgan and Pollock 1976) has begun to make wider claims concerning depression as it is affected by regular physical activity. In one report he indicated that "acute and chronic physical activity of a

vigorous nature offers a unique and effective method of reducing tension (state anxiety) and depression" (Morgan 1976, p. 17). In another paper (Morgan and Pollock 1976) similar claims are made; however, the writers caution one to keep in mind that this "improved sensation of well-being following acute and chronic exercise" (p. 3) may have other causes. The point is that when one decides to make a change in one's life-style such as embarking on a regular exercise routine, this may influence one's psychological well-being in a positive manner. In addition, when one decides to exercise regularly, changes in other habits such as eating and sleeping frequently occur, resulting in a generally more healthy life pattern overall.

In summary, the literature search produced a significant amount of empirical evidence demonstrating the positive relationship between exercise and an improved sense of well-being. In general, this improved sense of well-being was attributed to a decrease in anxiety and depression. Without question, the universal testimony to regular exercise is "feeling better." This feeling better may also include other components such as more positive body image, a sense of self-efficacy, more energy, and so on. Obviously much more research is needed before better insight and understanding are reached.

There is a dearth of systematic research addressing these questions and the methodological problems are great. At the same time, the relationship has been demonstrated sufficiently through personal testimony and the few studies that are reported to encourage the participation in regular exercise to reduce psychological stress. While directions are lacking with regard to length of time one should exercise, the degree of effort that should be put forth, and how much one's perception of what is happening influences the outcome, the conclusion that regular exercise is associated with feeling better can be made. When one feels better, one behaves in a more positive manner; how one feels about one's body has much to do with how one feels about oneself. In short, the bottom line may be self-esteem associated with a sense of "I can do it" that produces the positive feedback. Whatever the cause-effect relationship, there appears to be enough evidence to associate psychological well-being with regular vigorous exercise.

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The Physiological Responses of Females to Endurance Exercise

Harold B. Falls

This article focuses on female aerobic responses although performance in endurance exercise may require other qualities.

"Aerobic" implies metabolism with oxygen, i.e., the oxidative phosphorylation "segment" of the total metabolic process involved in degrading foodstuffs in the muscle cell. This would exclude the immediate energy that might be derived from (1) the splitting of adenosine triphosphate (ATP), or (2) glycolysis (the glycogen to lactic acid pathway). A high level of functioning as far as oxidative phosphorylation is concerned requires a high rate of oxygen delivery to the muscle cells. This is directly measured as the maximum oxygen consumption (max $\dot{V}O_2$). Oxygen consumption, in turn, is a function of cardiac output ($\dot{Q}$) and arteriovenous oxygen difference (Δ A-$\bar{V}O_2$). Thus

$$(1)\quad \dot{V}O_2 = \dot{Q} \times \Delta \text{ A-}\bar{V}O_2$$

cardiac output is a product of heart rate (HR) and stroke volume (SV) of the heart.

$$(2)\quad \dot{Q} = HR \times SV$$

As far as the health-related effects of exercise are concerned, epidemiologists have not been able to identify any adverse consequences of having a less than high Δ A-$\bar{V}O_2$, or even one that is somewhat below normal. They have, however, identified that there are probably some relationships between the development of circulatory diseases and certain levels of cardiac output below normal or perhaps below an optimum level that is yet to be identified. Thus in terms of the health aspects of aerobic exercise, emphasis should be on the cardiac output as the important function. However, if we are going to talk about physical performance in relating the events in winning the Boston marathon, we would also have to take into consideration Δ A-$\bar{V}O_2$.

I disagree with one point made by Dr. Harris, in a previous article. I think most of the literature indicates that there is not really a difference between males and females on maximum heart rate if they are in the same relative state of training. Therefore, maximum cardiac output differences between the sexes are primarily a reflection of differences in maximal stroke volume.

The responses of max $\dot{V}O_2$, $\dot{Q}$, SV, and HR to aerobic exercise training and the reverse (sedentary habits) have been demonstrated by Saltin *et al.* (1968) Figure 1).

Again, I am just trying to emphasize that from an aerobic-exercise standpoint, and especially from a health standpoint, we are dealing primarily with cardiac output and with stroke volume of the heart as far as maximum performance is concerned because if we compare males and females, there is very little difference in maximum heart rate and actually very little change in maximum heart rate with training.

A legitimate question is, "Do males and females respond differently to exercise?" First, let's look briefly at the overall male response to both exercise training and sedentary habits, again from the work of Saltin *et al.* (1968) (Figure 2).

In the study represented by Figure 2, max $\dot{V}O_2$, was measured before and after 21 days of bed rest in two trained and three sedentary young adult males. They were also measured during and after 8 weeks of exercise training that followed the bed rest. It is easily seen that all the subjects decreased in aerobic capacity with bed rest and increased

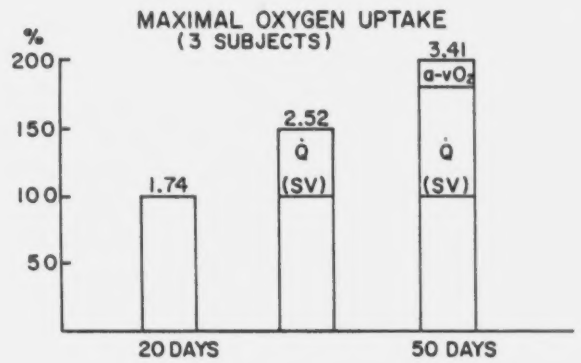

Figure 1. *Maximal oxygen uptake during treadmill running for three subjects (1) after bed rest (= 100%), (2) when they are habitually sedentary, and (3) after intensive training, respectively. The higher oxygen uptake under sedentary conditions compared with bed rest is due to an increased maximal cardiac output. The further increase after training is possible due to a further increase in maximal cardiac output and a small increase in arteriovenous oxygen difference. The maximal heart rate was the same throughout the experiment. Therefore, the increased cardiac output was due to a larger stroke volume. (From Åstrand and Rodahl 1977. Reprinted with permission of McGraw-Hill Book Co.)*

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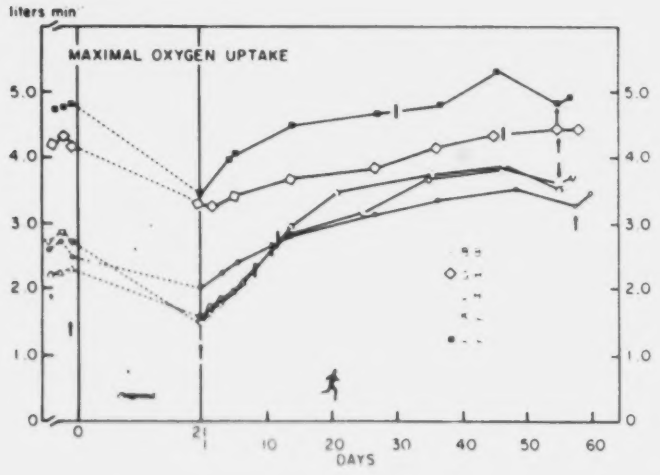

Figure 2. Changes in maximal oxygen uptake, measured during running on a treadmill, before and after bed rest and at various intervals during training; individual data on five subjects. Arrows indicate circulation studies. Heavy bars mark the time during the training period at which the maximal oxygen uptake had returned to the control value before bed rest. (From Saltin et al. *1968. By permission of American Heart Association, Inc.)*

with training. In fact, compared with the beginning of the study, the sedentary subjects were about 33 percent higher on max $\dot{V}O_2$ after the training. This is a general response to exercise in males verified by many other studies. If one is inactive or very sedentary, he will decrease in aerobic capacity, whereas if one trains, and the training program observes the proper mix of intensity, frequency, and duration, $\dot{V}O_2$ max will increase.

Similar data on females are limited, but many have become available over the past few years. One study by Burke (1977) (Figure 3) compared college-age male and female responses to an 8-week training program. There was also a control group. In both cases, the subjects were sedentary. Both males and females improved during the 8 weeks at approximately the same rate. The major apparent sex difference is that the females were about 20 percent lower than the males on max $\dot{V}O_2$ at the beginning of the study, and this relative difference was maintained throughout.

Another recent study compared the effects of bed rest in both males and females. Although the females exhibited a 40 percent lower max $\dot{V}O_2$ before bed rest, both groups decreased 9-10 percent on the measurement as a result of the period of bed rest, which was slightly shorter than in the study of Saltin *et al.* (1968) (Convertino *et al.* 1977).

Male-female aerobic-power changes have been compared longitudinally from the aging perspective by measuring max $\dot{V}O_2$ at a 21-year interval (Table 1). There was a decrease in both sexes, and the rate of decrease was very nearly the same in both, whether one compares on max $\dot{V}O_2$ in liters $\times$ min^{-1} or ml $\times$ kg $\times$ min^{-1}. Both males and females at age 42-46 were at about 80 percent of their max $\dot{V}O_2$ values exhibited 21 years earlier at age 22–25.

Similar results have been obtained by others. The studies cited above are merely good examples of the pattern of responses seen when males and females of similar fitness status are directly compared. The responses to exercise and training appear to be very similar. Differences do seem to be operating in regard to the degree of response between the sexes and in relative position on a continuum of aerobic capacity. In the remainder of this presentation. I want to focus on some of the factors I feel seem to explain those differences.

The Continuum Of Aerobic Power

I feel very strongly that we can view the entire range of aerobic power as a continuum that includes both male and female values (Figure 4). Lowest values (ml $\times$ kg $\times$ min^{-1}) in the population would likely be about 10-15. Highest known values for males approach 95 ml $\times$ kg^{-1}. The highest value of which I am aware for a female is 74 ml $\times$ kg^{-1}. This value compares very favorably with many male marathon champions and other world-class long-distance runners and Nordic skiers.

Factors that contribute to high or low max $\dot{V}O_2$ are shown in Figure 4. Population averages are about 45-50 ml $\times$ kg $\times$ min^{-1} for the male and 35-40 ml $\times$ kg $\times$ min^{-1} for the female. We see a difference in the highest known values, and we see a difference in the average values. However, I still think the trait can be viewed as a continuum, and I have tried to represent this in terms of normal distributions for aerobic power based on the means and standard deviations (SD) for Swedish young adult physical education students presented in Åstrand's classic 1949 work (Åstrand 1952) (Figure 5). Mean values for aerobic power were 58 and 48 ml $\times$ kg $\times$ min^{-1} for males and females respectively. I think we can reasonably view his data as samples from a normal population and use the SD to roughly picture the way the separate male and female distributions would look when plotted out

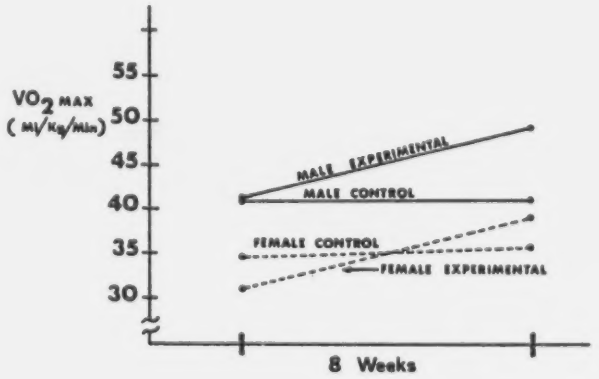

Figure 3. Changes in aerobic power during 8 weeks of training in young adult males and females. (From Burke 1977).

Table 1
Maximum Oxygen Consumption in Male and Female Physical Education Students after a 21-year Interval

	$l \times min^{-1}$		$ml \times kg \times min^{-1}$	
	male	female	male	female
1949	4.09	2.83	58.5	47.3
1970	3.28	2.20	45.3	38.4

Source: I. Åstrand, P.O. Åstrand, I. Hallbäck, and Å. Kilbom. Reduction in maximal oxygen uptake with age. *Journal of Applied Physiology* 35:649–654, 1973.

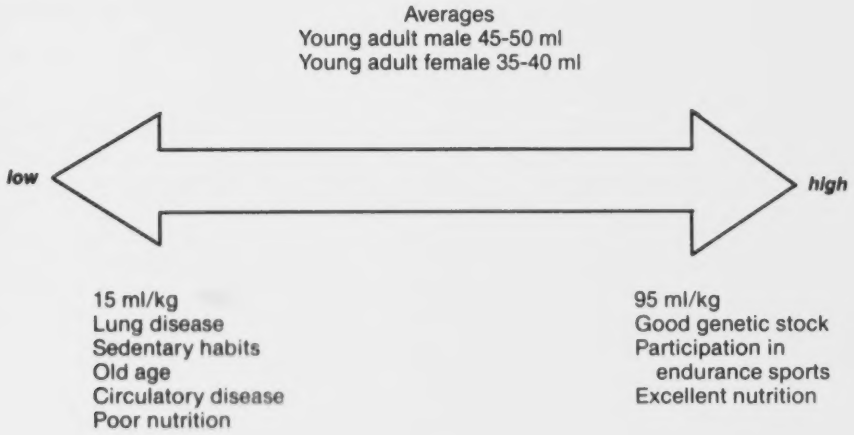

Figure 4. *The continuum for maximum oxygen uptake. Values are in* $ml \times kg \times min^{-1}$.

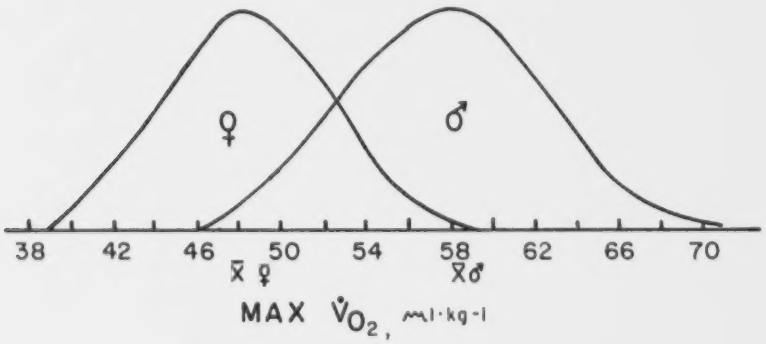

Figure 5. *Overlapping male and female distributions for max* $\dot{V}O_2$ *when ± 3 standard deviations are considered. (Based on data presented in Åstrand 1952.)*

± 3 SD from the respective means. What we then see is that the mean male value is included within the distribution for females, and the mean for females within the range of the distribution for males. There would be considerable overlap between the two distributions.

Further support for this concept comes from material in Astrand and Rodahl's textbook on work physiology (Astrand and Rodahl 1977) where they have presented the max $\dot{V}O_2$/age relationship (Figure 6). The more solid lines represent the mean max $\dot{V}O_2$. Up to about age 10, there is essentially no difference in the male and female values. After that age, males continue to increase while females tend to level off, and then both sexes decrease as they continue to age up through the range of age shown in Figure 6. The lighter lines represent ± 2 SD for each of the distributions. Again, considerable overlapping of distributions is noted as in Figure 5. Viewing the overlapping of distributions in this way, it appears that the average female compares almost directly with the untrained male in terms of aerobic power. The questions that become of most interest then are (1) what physiological and anatomical differences explain the different relative positions of males and females on the continuum, and (2) what are the implications for aerobic exercise prescription?

Anatomical and Physiological Differences

Heart Size

Table 2 presents data from a large study of heart size in the Soviet Union. It shows that the female heart is about 85 percent as large as that of the male when comparisons are made on absolute volume. There have been some arguments that if one corrects for body size, this difference disappears. Not so. When the heart size is expressed as $ml \times kg^{-1}$, $ml \times m^2$, or as a weight measure in $gm \times kg^{-1}$, the female heart is still 80-90 percent as large as that of the male (Åstrand *et al.*, 1964; Grande and Taylor 1965).

The maximum stroke volume is positively related to the heart size (Figure 7). In the young adult, the SV of the male is about one-third larger than in the female (Åstrand and Rodahl 1977). In younger persons, there doesn't appear to be a difference, or perhaps as large a difference. However, there really aren't enough data available on maximum SV in young females to be certain. If SV isn't smaller in young females compared with young males, it could mean there is also not a significant difference in heart size at those ages.

Blood Hemoglobin

After about 11–12 years of age, there is a difference in the hemoglobin concentration of the blood in males (15 $gm \times 100$ ml $blood^{-1}$) compared with females (12.5-13 $gm \times 100$ ml $blood^{-1}$) (Altman and Dittmer 1971). Since each gram of hemoglobin (Hb) will carry about 1.34 ml 0_2, this means a reduced oxygen-carrying capacity for her blood. Figure 8 shows the classical oxyhemoglobin dissociation curve usually found in physiology and exercise physiology textbooks. These curves are a representation of Δ A-$\bar{V}O_2$. Note that in most textbooks the curve presented is based on male

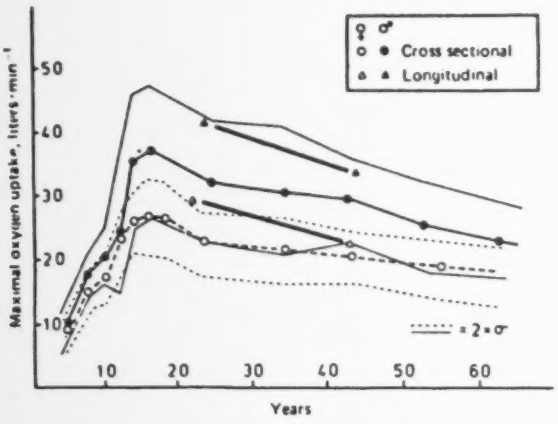

Figure 6. *Mean values for maximal oxygen uptake measured during exercise on treadmill or bicycle ergometer in 350 female and male subjects four to sixty-five years of age. (From Åstrand and Rodahl 1977. Reprinted by permission of McGraw-Hill Book Co.)*

Table 2
Heart Volumes of Athletes and Nonathletes*

	Males	Females
Athletes	860	725
Nonathletes	670	580

*Measurement in milliliters.
Adapted from data presented by K. A. Abramyan and R. A. Dzhuganyan. Athlete heart measurements. *Theory and Practice of Physical Culture* 12:27-29, 1969.

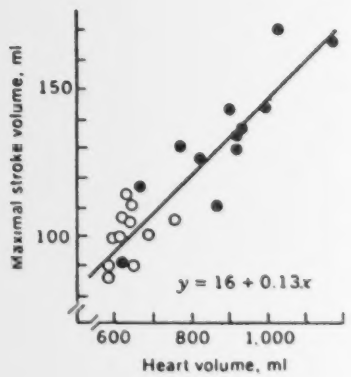

Figure 7. *Relationship between heart volume and maximal stroke volume of the heart. (From Åstrand et al. 1964. Courtesy of the American Physiological Society.)*

values (15 gm Hb × 100 ml blood^{-1}) The female's blood does not reach 19-20 vol. percent for 0_2 shown in these curves as it passes through the pulmonary capillaries. This is shown in Figure 9 where the normal female oxyhemoglobin dissociation curve (Hb = 12.5) is compared with the curve for a normal male (Hb = 15) and one typically found in anemia (Hb = 10). Since the venous 0_2 content during maximal exercise is approximately the same in males and females (Åstrand and Rodahl 1977) (Figure 10), the net effect of reduced hemoglobin is a narrower Δ A-$\bar{V}o_2$ leading to a reduction of max $\dot{V}o_2$ according to the relationship in Equation 1.

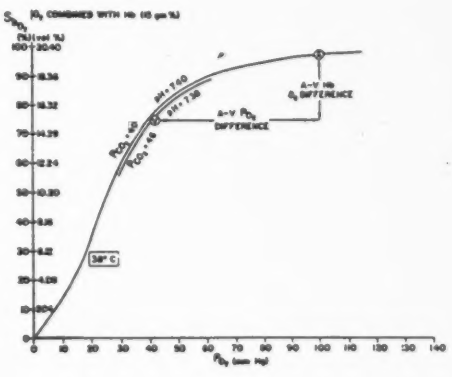

Figure 8. *The oxyhemoglobin dissociation curve, showing the relationship of blood oxygen transport. The full curve applies to the arterial blood of healthy man at rest. The small section to its right applies to venous blood. Point* a *represents normal values for arterial blood, and point* v, *for venous blood.*

Because of the lower max Δ A-$\bar{V}o_2$ the female's maximum performance in aerobic exercise is likely to suffer. If Δ A-$\bar{V}o_2$ in Equation 1 is reduced for a given $\dot{V}o_2$, Q must be increased. It has been shown that at a $\dot{V}o_2$ = 1.5 liters, the male can transport sufficient oxygen at a cardiac output of 12 liters × min^{-1} while 13.5 liters are required in the female (Åstrand and Rodahl 1977). Thus reduced Δ A-$\bar{V}o_2$ has a tremendous impact on the efficiency of using whatever cardiac output is available within a given individual.

Percentage Body Fat

Another factor that has already been mentioned by Dorothy Harris is the body-fat differential between males and females. In a typical young adult male, fat comprises 12–15 percent of the total body composition. Similar values for the young adult female are 20–28 percent (Katch and McArdle 1977). As in the case of max $\dot{V}o_2$, this difference becomes apparent at about age 10 and continues throughout the remainder of the life span (Figure 11).

In my opinion, extra body fat is a handicap, regardless of the claims by some persons that it provides a metabolic reserve for greater endurance. These claims are not supported by research. It also adds excess baggage to the body, and one has to expend extra energy to transport that excess baggage as the

body moves from one place to another. It is very similar to taking an extra weight, trying it on the body where the fat is located, and taking it along with you. Recent research has shown that even though the cardiopulmonary response at any given $\dot{V}O_2$ is not increased by obesity, the oxygen required for any given workload *is* increased (Davies *et al.* 1975).

I do not mean to imply that the average female is obese compared to known or inferred health standards. That is certainly not the case, and there is evidence that a significant proportion of her fat is necessary for normal sexual and childbearing functions (Frisch and McArthur 1974). However, there is a relative obesity when she is compared with the average male. This decreases her functional aerobic capacity since max $\dot{V}O_2$ is divided by total body weight to arrive at the functional measure of max $\dot{V}O_2$ in ml × kg × min^{-1}. Excess body fat reduces the size of this quantity. One of the things I tell my own students is that they can increase their max $\dot{V}O_2$ in ml × kg × min^{-1} without exercising. All they have to do is lose a few pounds of extra fat.

Muscular Strength

For an equal body size the female has 5 to 10 percent less muscle mass relative to total body weight than the male (Behnke and Wilmore 1974). Therefore, the size of the musculature involved in a given exercise is less. For example, a female running, or otherwise using her legs in exercise, has a smaller muscle mass on those legs. She has less total strength in them than the male.

If the contractile force that must be exerted by a muscle is above about 20 percent of its maximum possible force, there is going to be at least some interference with blood flow. The greater the degree of necessary contractile force in comparison to that maximum possible force, the greater the cutdown of blood flow, and the more the person is going to have to resort to anaerobic metabolism in order to sustain the exercise (Lind and McNicol 1966; Whipp and Phillips 1970).

This problem is well illustrated by Figure 12. The upper two curves show lactate accumulation in a 15-minute bicycle ergometer ride in two low-strength males working at 80 percent max $\dot{V}O_2$. The lower curve is from a strong male also working at 80 percent max $\dot{V}O_2$. Lactate accumulation is much less in the stronger male, an indication that the weaker individuals were having to use anaerobic metabolism to a greater extent, even though they were all working at the same relative intensity. The weaker men were forced more into anaerobic metabolism not so much because they couldn't handle the exercise aerobically, but more because they didn't have the strength to effectively overcome the resistance of pushing the bicycle pedals around. The female is at the same disadvantage as the weaker males in Figure 12. Her lower strength levels will force her into anaerobic metabolism at a lower resistance than the male who is stronger.

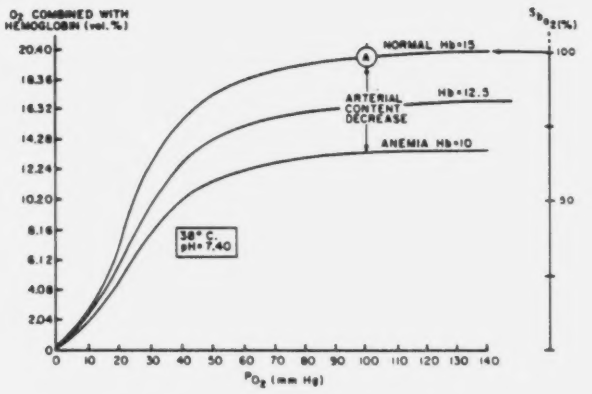

Figure 9. *The oxyhemoglobin curve for normal male, normal female, and in anemia.*

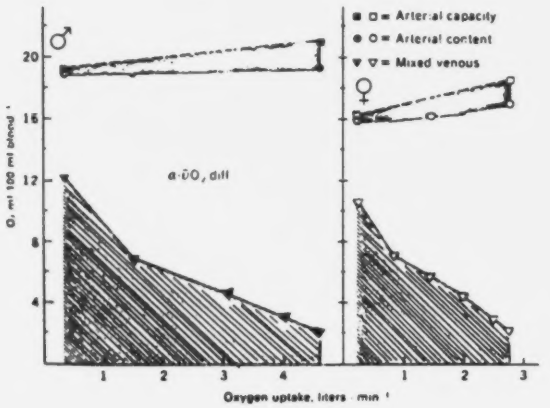

Figure 10. *Oxygen binding capacity and measured oxygen content of arterial blood; calculated oxygen content of mixed venous blood at rest and during work up to maximum in males and females 20 to 30 years of age. During maximal work, the arterial saturation is about 92 percent as compared with 97 to 98 percent at rest, and the venous oxygen content is very low and similar for women and men. (From Åstrand and Rodahl 1977. Reprinted by permission from McGraw-Hill Book Co.)*

Implications For Aerobic Exercise Prescription

Intensity of Exercise

Intensity of exercise has been shown to be one of the important criteria in exercise prescription, and the American College of Sports Medicine (ASCM) recently issued a position statement recommending the minimum threshold for aerobic conditioning as 60 percent of maximum heart rate reserve [60% (max HR – Resting HR) + Resting HR] or 50 percent of max $\dot{V}O_2$ (ACSM 1978).

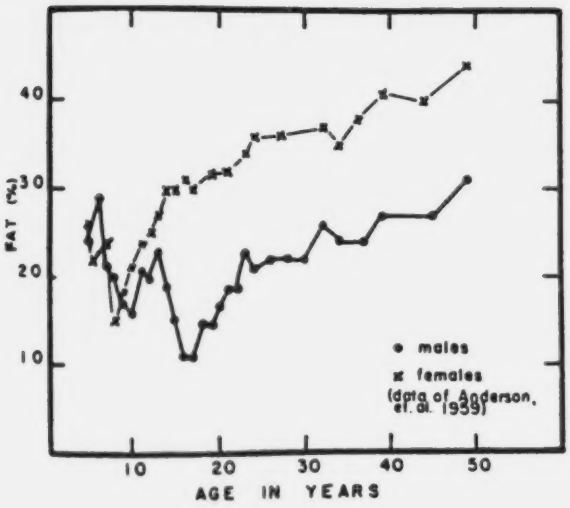

Figure 11. *Average percentages of fat in the body as a function of age and sex. (From G. L. Rarick, H. J. Montoye and V. Seefeldt: Growth, development, and body composition. In H. J. Montoye (Ed.).* An introduction to measurement in physical education. *Indianapolis: Phi Epsilon Kappa Fraternity, 1970.)*

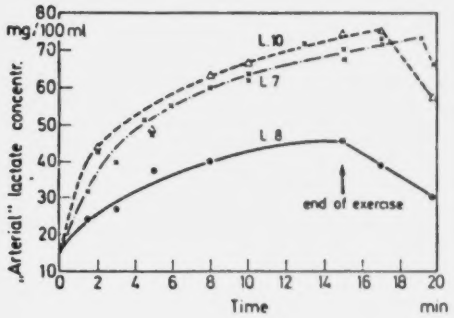

Figure 12. *The course of lactate accumulation during 15 minutes of exercise at 80 percent of maximal aerobic power. Data are for one muscular (L 8) and two other subjects. (From C. Kay and R. J. Shephard, On muscle strength and the threshold of anaerobic work.* European Journal of Applied Physiology. *27:311-328, 1969.)*

A shortcoming of these recommendations is that they are based primarily on research on male subjects. Very little research has been conducted on determining minimum or optimum intensity, duration, and frequency of conditioning exercise in females (ACSM 1978; Pollock 1973). Even though females respond to aerobic exercise in a manner similar to the male response, the anatomical and physiological differences noted above do result in a different heart rate/$\dot{V}O_2$ relationship (Figure 13). Therefore, the $\dot{V}O_2$ associated with a given heart rate in the female is different from that in the male. An example is easily obtained from the physical education students used in the construction of the Classic Åstrand-Rhyming nomogram for estimation of max $\dot{V}O_2$ from submaximal work (Åstrand and Rhyming 1954). At oxygen uptakes that were 50 and 70 percent of max, the males had mean heart rates of 128 and 154 respectively. The corresponding pulse rates for the female subjects were 138 and 168 — a difference of 10-14 beats × min^{-1}. These differences certainly indicate that more research on the female is needed in exercise prescription to determine if the guidelines currently used with males are equally applicable to females.

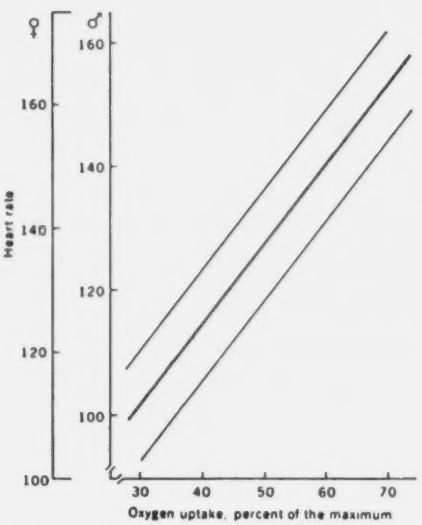

Figure 13. *Relationship between heart rate during work (bicycle ergometer) and oxygen uptake expressed in percentage of subjects' maximal aerobic power. Left of ordinate, heart rates of women; right of ordinate, those of men. Thin lines denote one standard deviation. (From Åstrand and Rodahl 1977. Reprinted by permission from McGraw-Hill Book Co.)*

Anaerobic vs. Aerobic Exercise

Because the female has lower strength, any prescribed aerobic exercise based on the ACSM guidelines will likely be more anaerobic in the female because of the greater occlusion of blood flow. This is another area requiring further research to provide a basis for any adjustments that might be necessary in the exercise prescription for female participants.

Strength and Injury Prevention

A significant problem in most aerobic conditioning programs is keeping the exercise intensity at a level that will not predispose the participant to orthopedic injuries. Because of her lower strength, I think the female runs a greater risk of these injuries at any given intensity of exercise when compared with the male. Stronger muscles help to stabilize the joints better during movement and also during various activities requiring fixation of body segments. Stronger ligaments and tendons are usually also associated with stronger muscles. This is something that needs to be carefully considered when prescribing exercise for the female.

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Implementation of Health Related Physical Fitness

How Much Exercise Is Enough?

Michael L. Pollock, PhD

Whether the patient is young or old, fat or thin, fit or flabby, long-term involvement in an exercise program can significantly affect health. Exercise prescriptions should be based on the present level of fitness as well as the individual's specific goals.

How much exercise is enough? How much exercise for what purpose? The answers to these questions are difficult and tentative.

The various reasons people exercise to become physically fit depend on age, sex, and current levels of fitness and health. For example, needs and goals differ for elementary school children, athletes, and middle-aged men and women. School children need a broad spectrum of sports and activities to kindle their interests and to provide them with a broad educational experience. The activities of most elementary school programs should provide for physical development, but many existing physical education classes do not. Athletes' programs are geared to competitive situations in which maximum skill and physiological and psychological effort is necessary. To prepare for such events often requires two to three hours of rigorous training daily. Adults generally are concerned with maintaining strength and stamina, avoiding increases in body weight and fat, and avoiding potential health problems that occur with a sedentary life-style. Women often exercise for cosmetic reasons such as weight and figure control.

Physical fitness can be divided into three major categories: cardiovascular-respiratory fitness, physique, and motor function. Table 1 lists the major subcomponents of each category. Although this tabulation is considered comprehensive in the way it describes fitness, the various subcomponents are usually emphasized differently depending on age, needs, and goals.

Adult fitness programs should be designed to develop and maintain car-

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Table 1. Physical Fitness Categories

Cardiovascular-Respiratory	Physique	Motor Function
Heart	Body Type	Strength
Circulation	Composition	Endurance
Pulmonary (Lungs)	Bone	Flexibility
	Muscle	
Working Capacity	Fat	Power
	Posture	Agility
		Balance

Table 2. Recommendations for Exercise Prescription for Healthy Adults*

Frequency	3 to 5 days/week
Intensity	60% to 90% of maximum heart rate 50% to 80% of maximum oxygen uptake
Duration	15 to 60 minutes (continuous)
Mode (activity)	Run, jog, walk, bicycle, swim, or endurance sport activities
Initial level of fitness	High = higher work load Low = lower work load

*These factors can be applied to athletes as well as diseased persons. The prescription will differ in that the athlete will require more frequent and exhausting bouts of work, and the diseased person a more conservative regimen with more interval work.

diovascular-respiratory fitness, flexibility, and muscular strength and endurance that is consistent with personal exercise goals and work requirements. These programs should include endurance activities such as running, fast walking, bicycling, swimming, skating, etc, which can be sustained for a 15- to 60-minute period. The exercise period should start with a 10- to 15-minute warm-up and muscle conditioning period, and end with a 5- to 10-minute cool-down. The length of the endurance period usually is dependent on the intensity of effort. The endurance program is designed to burn a minimum of approximately 300 calories per workout. Thus, if done often enough, it will trim body weight and fat and improve or maintain cardiovascular-respiratory fitness. The warm-up and muscle conditioning period should include stretching and conditioning exercises to develop and maintain flexibility, strength, and endurance of the major muscle groups.

To receive optimal health and fitness benefits, participants should start programs early in life and continue for a lifetime. Improvement with short-term experiments (three to six months) will not affect health-related factors as significantly as long-term involvement. Also, participants probably will not be able to develop or maintain full physiological potentials unless the training programs are initiated early in life and/or continued for a long time.

Strength and muscular endurance are necessary to maintain proper muscle tone and to protect against injury and low back pain. Flexibility exercises are important for similar reasons and should be practiced often. Reduced flexibility can lead to poor posture, fatigue, and injury. An endurance activity such as jogging can reduce the flexibility of the extensor muscles of the hip, leg, and ankle. Thus, avoiding proper stretching exercises for these areas could lead to low back, hamstring, or calf muscle problems.

The program prescribed for an adult depends on needs, goals, physical and health status, available time, equipment, and facilities. This information is available through medical history records, physical fitness and medical evaluations, and personal interviews. After a thorough evaluation, an exercise prescription is made.

Exercise Prescription

Exercise prescription is based on frequency, intensity, duration, mode of activity, and initial level of fitness. Table 2 lists guidelines for exercise prescription for average adult men and women. These recommendations are based on several factors:

1. The participants are adults who are not participating in athletic competition.

2. The participants are engaged in a general physical fitness program to develop and/or maintain cardiovascular-

respiratory fitness, body composition, muscular strength and endurance, and flexibility.

3. The participants are generally healthy and free from severe disease such as coronary heart disease, pulmonary disease (emphysema), or neuromuscular problems (muscular dystrophy, multiple sclerosis, etc).

The recommendations for exercise prescription shown in table 2 emphasize the endurance phase of a training program and focus on preventive health and cardiovascular-respiratory fitness. Flexibility and muscular strength and endurance activities are important aspects of a well-rounded comprehensive program, but the detailed rationale for only the cardiovascular-respiratory component will be described. The quantification is based on years of scientific investigation to find the optimal training prescription for adults. These recommendations are the best estimates available at this time, but more investigation is necessary before the final plan can be adopted.

Much of the evidence used to establish the recommendations in table 2 was based on a series of 20-week training experiments conducted on healthy (but sedentary) adult men. In these experiments, many physiological variables were evaluated, but for the purpose of this article, the justification of the recommendations will be based on the values for maximum oxygen uptake (which represents changes in cardiovascular-respiratory fitness), and body weight and fat (which represents changes in body composition). Good cardiovascular-respiratory function depends on efficient respiration (lungs) and cardiovascular (heart and blood vessels) systems. Other important factors include the quality of the blood (red blood cell count, blood volume, etc) and specific cellular components to help the body utilize oxygen during exercise.

The ability to utilize oxygen at maximum is the best representation of these factors. Maximum oxygen uptake (aerobic capacity) is the largest amount of oxygen that can be utilized under the most strenuous exercise. Because maximum oxygen uptake generally summarizes what is happening in the oxygen transport system (including cellular utilization) during maximum or exhaustive exercise and can be measured easily, it has been used as the measure most representative of cardiovascular-respiratory fitness. A larger person generally has more muscle mass, and thus the capability of using more oxygen. To more easily compare persons of different sizes, aerobic capacity is expressed in milliliters of oxygen per kilogram of body weight per minute (ml/kg/min).

Figure 1 shows a champion distance runner taking a treadmill test to determine maximum oxygen uptake. Figure 2 shows a comparison of maximum oxygen uptake values of young and middle-aged men of various fitness levels. The figure clearly shows the difference in aerobic capacity as related to status of fitness and age. Values for women are approximately 10% to 20% lower.

Is there a level of aerobic capacity necessary to attain and maintain an optimal level of health and cardiovascular-respiratory fitness? It is difficult to set a standard for optimal fitness because a specific level of aerobic capacity for op-

A specific level of aerobic capacity for optimal health has not been determined.

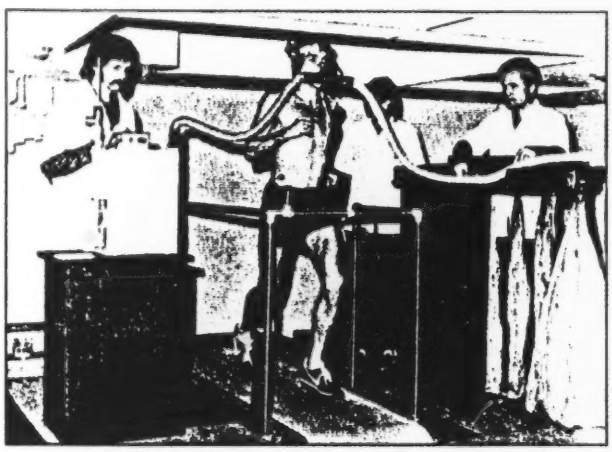

Figure 1. *The maximum oxygen uptake test is being administered to premier distance runner, Steve Prefontaine. At the time of this test, Prefontaine held ten American distance running records. His maximum oxygen uptake was 84.4 ml/kg/min, one of the highest values ever recorded for a runner. Breathing valve channels all expired air into a series of bags, which were later analyzed for O_2 and CO_2 content.*

timal health has not been determined. As shown in figure 2, sedentary middle-aged males characteristically fall below 40 ml/kg/min of oxygen uptake. This value drops to 30 by age 50 or 60. Many experts feel that a person should maintain or develop his aerobic capacity to above 40 ml/kg/min. Until more evidence is available, the minimal threshold standard for optimal fitness seems to be oxygen uptake between 38 to 45 ml of oxygen per kg per minute for men 20 to 60 years of age.

The maximum oxygen uptake value is partially controlled by heredity; that is, a person of Olympic caliber who has a maximum oxygen uptake over 70 or 80 ml/kg/min is born with this characteristic. This does not mean that the champion athlete does not have to train hard to further develop this potential. For example, when Jim Ryun (at the time world record holder in the mile run) stopped training for approximately 18 months, his maximum oxygen uptake dropped from 81 to 65 ml/kg/min (20%) as a result of his reduced fitness and increased body weight. Even though he was out of shape, he continued to have a high maximum oxygen uptake. Maximum oxygen uptake varies approximately 20% when one is in or out of training. This can be further reduced with age; thus, the optimal level of improvement generally found in training programs is approximately 15% to 25%.

Figure 3 shows a person being measured for body fat by two methods, and figure 4 shows body fat values of various groups of men. The body fat of women averages 5% to 10% higher than men. As shown in figure 4, trained persons of various ages are less fat than their sedentary counterparts. The optimal level of fat is not known exactly, but most experts agree that men should stay below 16% to 19% and women below 23% to 25%.

Quantifying Results of Endurance Training Programs

Cardiovascular-respiratory fitness improves as a result of many factors. In general, the degree of improvement depends on the total work or energy cost of the exercise program. Energy cost can be measured by the number of calories expended. Improvement in aerobic capacity and body composition depends on the frequency, intensity, and duration

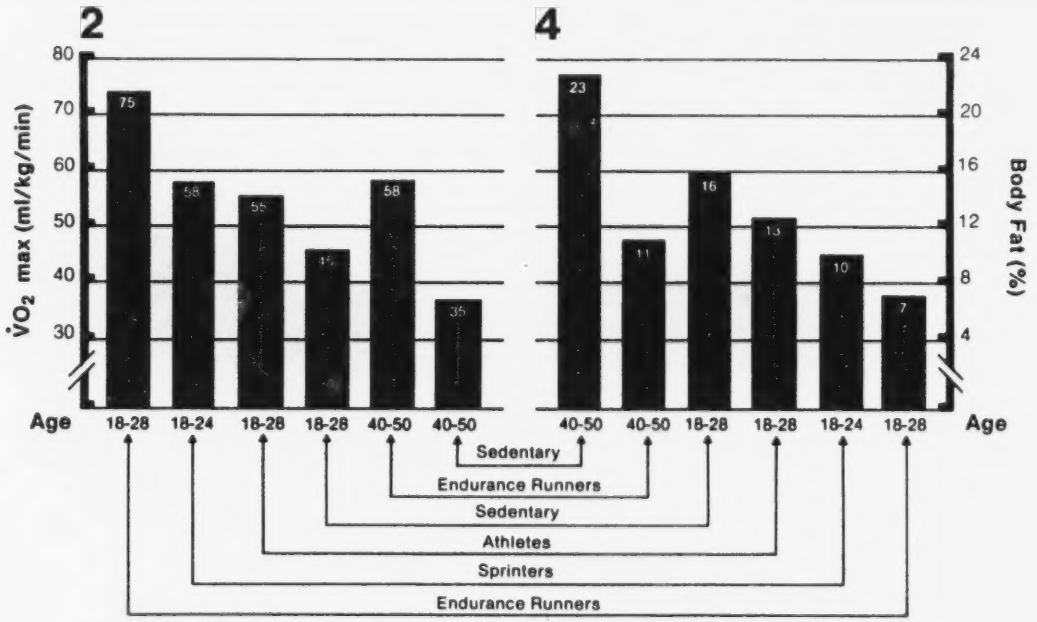

Figure 2. *Comparison of maximum oxygen uptake of young and middle-aged men of various fitness levels*

Figure 4. *Percent body fat values of selected groups of men*

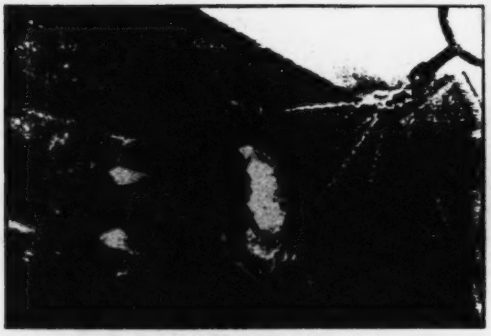

Figure 3a. Body fat determination by the underwater weighing technique

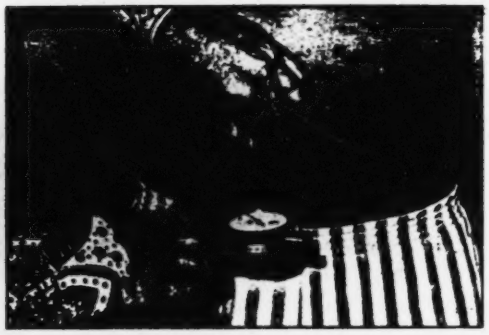

Figure 3b. Body fat determination by the skinfold fat technique (This method correlates well with the underwater weighing technique.)

of the exercise program. Improvement is also related to the initial status of health and fitness, the mode of exercise (walking, running, cycling, skating, etc), the regularity of exercise, and age.

Frequency

To answer the question "How many days per week are necessary to develop fitness?" we designed an experiment to train men at either one, three, or five days per week. Intensity of training was standardized at 85% to 90% of maximum, with the men participating for 30 minutes each exercise session. Figure 5 shows that maximum oxygen uptake improves in direct relation to the frequency of training; that is, 8%, 13%, and 17%, for one, three, and five days per week, respectively. Another investigation we conducted comparing two and four days per week of training showed similar results. The two day per week program showed a significant improvement in aerobic capacity that was approximately equal to that found in the three day per week program.

One might ask, "Why recommend a minimum of three days per week, rather than two, if a person can get approximately the same amount of improvement?" First, the two-day studies were

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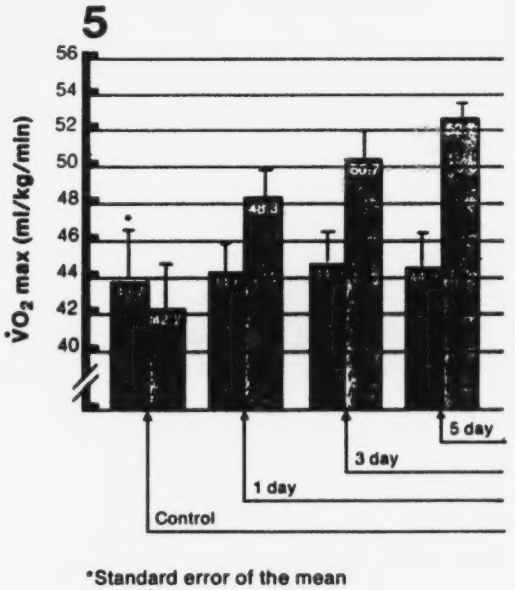


Figure 5. Effects of different training frequencies on maximum oxygen uptake

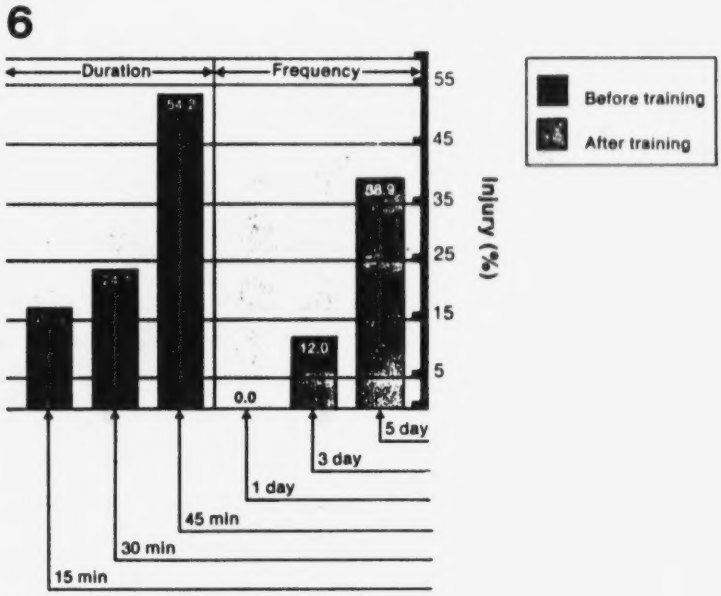


Figure 6. Effects of frequency and duration of training on incidence of injury

The injury rate increased dramatically when joggers trained more than three days per week.

of a high-intensity nature, which may not be suitable or enjoyable for adults. The second reason is that no body weight or fat loss occurred in the two-day program, but it did in the three day per week studies. Three subsequent investigations in which men trained two days per week (up to 4 miles per workout) also showed no changes in body weight or fat. Thus, it appears that the minimum of three days per week is necessary to develop cardiovascular-respiratory fitness and to show significant changes in body weight and fat.

How about training more than five days per week? Certainly, training more than five days per week is possible, but our experience finds it unrealistic. Most adults cannot fit more than three or four days a week into their busy schedules. In addition, the amount of improvement in exercising more than five days per week is minimal and probably not worth the added effort unless competition is involved. Most importantly, the injury rate related to the foot, ankle, and knee joints increased dramatically when joggers trained more than three days per week.

Figure 6 illustrates a study we conducted on young adult men who trained one, three, or five days per week. The rate of injuries for the five day per week group was three times that of the three day per week group. A participant with a jogging-related injury had to stop training for at least one week. The injury rate also increased significantly when the duration of training increased from 30 to 45 minutes per workout (3 1/2 to 5 1/2 miles). It appears that the body needs sufficient rest between workouts, and that a day's rest between the days of jogging may protect a participant from injury. If one wants to exercise more frequently, jogging activities should be interspersed with days of walking, bicycling, swimming, and other activities that do not cause the continual "pounding effect" on the legs. A soft jogging surface and shock-absorbent shoe insoles also help.

The injury study (both frequency and duration) relates to beginning joggers and should not be extrapolated to other situations. For the present, however, it gives enough information to recommend a day's rest between workouts and to recommend keeping the duration of endurance effort to less than 30 minutes for beginning joggers. More frequent and longer workouts may be tolerated as one gets in better shape.

It is not known at this time whether a five, six, or seven day per week program will elicit a more significant effect on other health-related variables such as high-density lipoproteins. If future research shows this to be the case, modifications to these recommendations must be considered.

Closely related to frequency of training is the regularity with which one participates and the subsequent effect on cardiovascular-respiratory fitness. If training is not continued, the improvement gained or maintained in a program diminishes rapidly. Significant reductions in fitness have been found after only two weeks of detraining. In one study, participants trained at equal eight-week periods of activity, nonactivity, and activity, with subsequent significant improvement, decrement, and improvement found in aerobic capacity. Also, studies in which subjects are put to bed for extended periods have shown decrements in aerobic capacity and related cardiovascular parameters.

To determine the effects of different levels of detraining, we reevaluated 22 middle-aged men after a 12-week detraining period. Participants originally trained by running 8 miles per week for 20 weeks. They were subsequently divided into three subgroups: Group A continued to train 8 or more miles per week, group B trained 3 miles per week, and group C was inactive. The results showed that members of group A maintained and/or improved their levels of fitness, while groups B and C regressed significantly. Group B lost approximately 40% of its original improvement and group C lost 50% after just 12 weeks. Another study showed a regression to sedentary normal after eight months of nontraining.

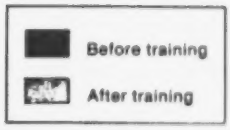
The dropout rate in a high-intensity interval training program was twice that of a continuous jogging program.

It is apparent from this review that training effects are both gained and lost quickly, and regular continued stimulation is necessary to maintain proper cardiovascular-respiratory fitness. Also, if persons refrain from exercise for any period, they must take precautions when resuming the program. Because of the reduced fitness caused by the layoff, these participants should start back slowly and gradually increase the training load to its original level.

Intensity

What is the optimal intensity level necessary to improve physical fitness? Two classic studies serve as practical guides for determining a minimal threshold level of intensity necessary for improving aerobic capacity. Both studies agree that the minimal threshold level for eliciting a training response is at a heart rate equal to 60% of maximum. The studies were conducted on younger men with training heart rate levels ranging from 130 to 150 beats per minute. For unfit, middle-aged, and older persons, the minimal training threshold may be as low as 100 to 120 beats per minute. A study conducted in Canada further substantiates the minimal threshold concept for eliciting a training effect and supports the idea that lower threshold levels exist for less-fit persons. They trained college men for ten minutes, five days per week for five weeks at heart rates of 120, 135, or 150 beats per minute. When groups were subdivided into high- and low-fitness levels, the high-fitness group showed no improvement at heart rates of 120 and 135 beats per minute while the unfit group did.

Although the minimal intensity threshold concept is generally well-accepted, it is also well-established that improvement in aerobic capacity is directly related to the intensity of training. If the training session duration is short (five to ten minutes), low-intensity programs may show little (up to 5%) or no improvement in aerobic capacity (hardly appreciable), while a high-intensity program may elicit up to a 15% to 20% increase. In general, the adult population does not seem to enjoy or tolerate a high-intensity program. Recent studies we conducted at the Aerobics Institute in Dallas showed that the dropout rate in a high-intensity interval training program was twice that of a continuous jogging program. The program was conducted over a 20-week period, and the workouts were equalized for total energy cost. The physiologic effects of the training programs were equal; both groups improved significantly in aerobic capacity and lost



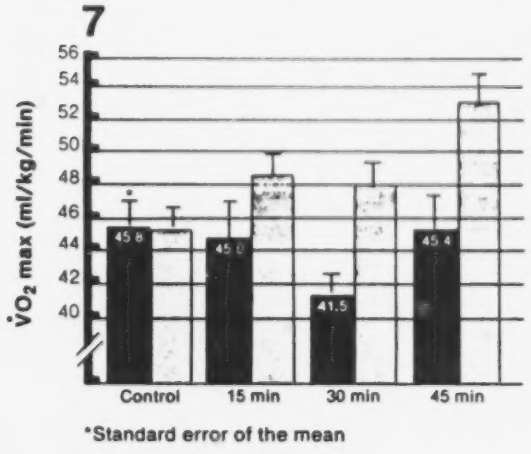


Figure 7. Effects of different training durations on maximum oxygen uptake (The moderate differences found among groups were not statistically significant.)

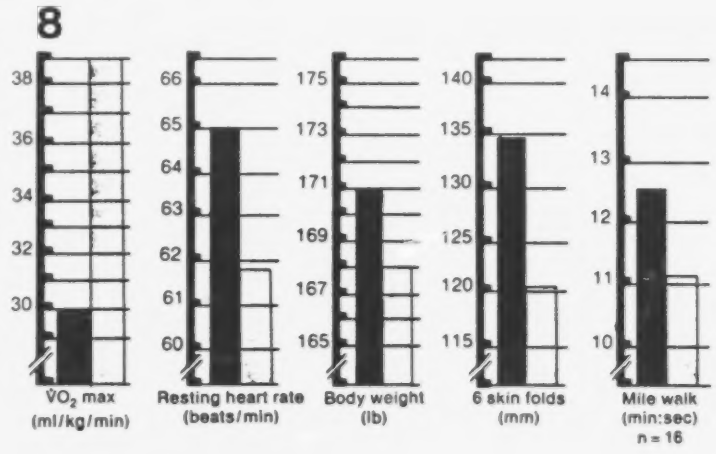


Figure 8. Effects of walking on the physical fitness of middle-aged men

body weight and fat. Another group of men in this experiment trained in interval training and jogging on alternate days and at the end of the study were asked which program they preferred. Ninety percent of this group preferred continuous jogging training to interval training. Also, more injuries were experienced with the interval training group. However, intensity of training usually depends on health status, level of fitness, and duration of training.

Duration

Improvement in cardiovascular-respiratory fitness is directly related to duration of training. Improvement in aerobic capacity has been shown with moderate- to high-intensity training lasting only five to ten minutes daily. However, the shorter duration programs of moderate intensity show a significantly lower training effect than programs of 30 to 60 minutes' duration. Figure 7 shows the results from a study we conducted on men 20 to 35 years of age for 20 weeks. The intensity was standardized at 85% to 90% of maximum, and the men participated three days per week. Improvement in maximum oxygen uptake was 8.5%, 16.1%, and 16.8% with 15-, 30-, and 45-minute duration groups, respectively.

It is important to reiterate that duration and intensity are interrelated and that the total amount of work (energy cost) accomplished in a training program is the most important factor for fitness development. For example, the energy cost of running is generally higher than walking, yet many men and women would rather walk than run. Since the intensity of walking is less than running, can one expect to get similar training effects by walking if the duration and frequency are increased? Several years ago we conducted a 20-week fast-walking study with men 40 to 57 years old. They walked for 40 minutes four days per week. The improvement in this program (figure 8) was equal to that in 30-minute, three day per week, moderate intensity jogging programs with men about the same age. The lower intensity of the walking program (65% to 75% of maximum) was offset by the increased duration and frequency of training. Thus, the energy cost of the walking program was equal to that of the jogging program.

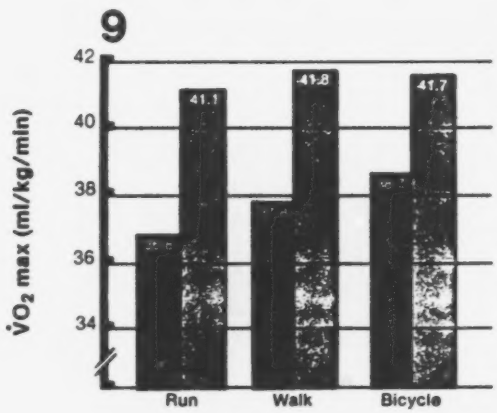


Figure 9. Effects of different modes of training on maximum oxygen uptake

To further illustrate this point, when we compared two jogging programs of different intensities (80% vs 90%), the results were similar when the total energy cost was equalized between them. This means that participants can slow down the pace, run several minutes longer (to make up for the lower calorie expenditure), and achieve approximately the same results. This is why the 15- to 60-minute duration range is recommended in table 2. If the minimum of 300 calories is recommended for an exercise program, then 15 minutes would require a fairly high-intensity effort, while walking may require 35 to 60 minutes.

The concept of the slower pace and longer duration has important implications for exercise prescription. First, compliance is an important factor in a training regimen. People participate in programs they enjoy. The lower-intensity effort makes the programs more enjoyable. Also, the musculoskeletal system can tolerate low-intensity work better than high-intensity work, which means that a participant can avoid unnecessary

Compliance is an important factor in a training regimen. People participate in programs they enjoy.

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No weight loss occurred unless the participants walked for more than 30 minutes daily.

injuries by working at a slower pace. Finally, it is often safer and more reasonable to exercise at a low to moderate intensity. This is particularly important for persons with reduced health status (suspect of coronary heart disease), middle-aged persons, and persons who are overweight.

One important point should be made concerning body weight and fat loss in relation to the exercise prescription. A study was conducted with obese women who exercised daily for one year or longer with no dietary restrictions. They lost weight in direct relation to the time spent walking. However, no weight loss occurred unless the participants walked for more than 30 minutes daily. It appears that a minimal threshold for weight reduction and fat loss by endurance training includes the following: continuous physical activity of 20 to 30 minutes' duration; sufficient intensity of exercise to expend 300 calories per session; and exercise frequency of at least three days per week. Because total energy expenditure is closely related to weight and fat reduction, increased frequency, intensity, and duration of training should elicit greater reductions.

Mode

Many people suggest that jogging or running is better than other endurance training programs. Is this true? If the total energy cost of the program is the most important factor, it seems that it would not matter which mode of training a person used as long as it burns the calories. To test this concept, about two years ago we conducted a study comparing running, walking, and bicycling training programs. In this study, frequency (three days per week), intensity (85% to 90% of maximum), and duration (30 minutes) of training were held constant for 20 weeks. To get the intensity level high enough with the walking program, the men trained by walking up a hill on a treadmill. The bicycle group rode resistance bicycles, which could be regulated to get the heart rates up to the required intensity. Changes in aerobic capacity (figure 9) and body composition showed similar improvements. Thus, it appears that a variety of aerobic activities can be interchanged for improving and maintaining physical fitness.

In general, activities with moderate to high energy cost, such as running (jogging), walking, swimming, bicycling, cross-country skiing, and game-type activities, show significant increases in cardiovascular-respiratory fitness and reductions in body weight and fat. In contrast, activities that are intermittent and low in energy cost (below the intensity threshold), such as golf, bowling, and moderate calisthenics, show no improvement.

What about weight lifting? We often hear about how tired a person is after a weight-training session. Also, the heart rate after a weight-training session seems to be quite high. Early studies testing the effect of weight training on cardiovascular-respiratory fitness showed no significant improvement. These programs often emphasized heavy weights with long periods of rest between exercises. Several studies have been conducted recently to evaluate the effect of weight training on aerobic capacity. In these experiments, men and women lifted moderate weights (approximately 50% to 60% of maximum) 10 to 15 times on 8 to 12 exercises using two to three sets (generally referred to as circuit weight training). The programs were as continuous as possible with little rest between exercises (15 to 30 seconds). The results were consistent. They showed large increases in muscular strength, but little (3% to 5%) or no change in aerobic capacity (figures 10 and 11). Therefore, weight training is not recommended for improving cardiovascular-respiratory fitness.

It should be noted that the heart rate/

oxygen cost ratio is different for arm and leg work. For an equal heart rate, the oxygen cost of arm work is about 68% of that of leg work. Thus, the high heart rates in some weight-training activities may be misleading regarding energy cost.

Initial Level of Fitness

The initial level of fitness is an important consideration in starting an exercise program. The threshold for improvement is lower with an unfit individual. What is the trainability of an older person? Is a person ever too old to get started? Age in itself is not a deterrent for participating in endurance work. Several studies have shown that middle-aged and old athletes can perform at high levels of work in their sixth, seventh, and eighth decades of life. Other reports on athletes who exercise regularly show similar results. The difference in beginning exercise programs for older individuals is that their initial level of fitness is lower, and the quantity and quality of work that they can tolerate is less. This means that the initial work loads (intensity) should be moderate and the rate of progression slower for older participants. To look at the trainability factor, we studied a group of men 49 to 65 years of age and found that their aerobic capacity improved 17% after 20 weeks of training. Other work conducted in gerontology centers has supported this conclusion. For every decade of age after 30, it takes about 40% longer for participants to progress in their training programs. That is, their adaptation to training is slower. For example, if one is involved in a walk/jog program and the distance run progresses every two weeks for men 30 to 39 years of age, the interval for progression may increase to every three weeks for participants 40 to 49 years of age, and every four weeks for participants 50 to 59 years of age.

For every decade of age after 30, it takes about 40% longer to progress.

Does physical fitness automatically decrease with age? There appears to be a decrement in physical fitness due to the aging process; however, if one stays physically active, the slope of decline

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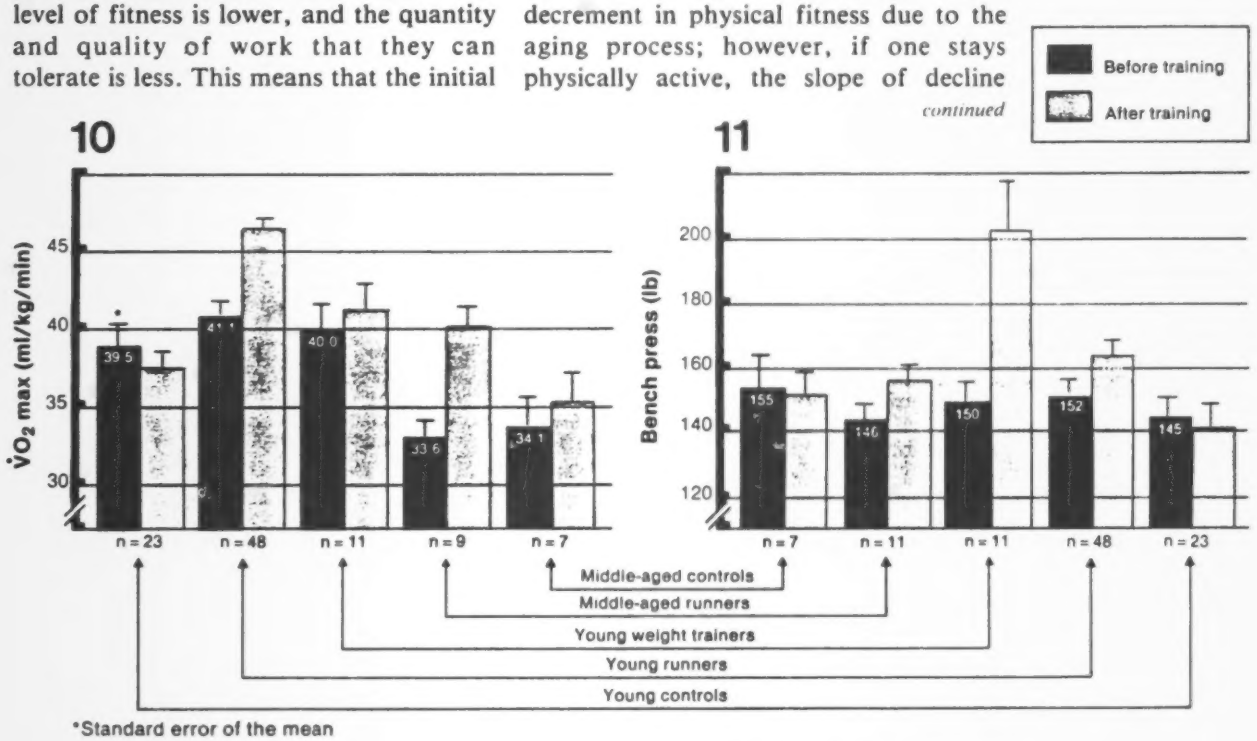

***Figure 10.** Effects of running and circuit weight training on maximum oxygen uptake*

***Figure 11.** Effects of running (and moderate calisthenics exercises) and circuit weight training on one repetition bench press strength*

may be less. In fact, recent evidence has shown that over a ten-year period when middle-aged men continued their training, they showed no decrement in aerobic capacity and body composition.[1] The men were 45 years old at the beginning of this study and continued to train approximately 60 minutes three days per week.

Summary

Research findings have shown that improvement in cardiovascular-respiratory fitness and reduction in body weight and fat is dependent on intensity, duration, and frequency of training. Intensity and duration of training were found to be interrelated, with the total calories expended during a workout being an important factor. Although there appears to be a minimal threshold level for improving cardiovascular-respiratory fitness (60% of maximum), programs of 15 to 60 minutes of continuous activity performed three to five days per week generally showed significant improvements in aerobic capacity and body composition. Age was not a deterrent to initiating or continuing an exercise program, but it is recommended that older participants and/or those with low initial levels of fitness begin their programs at a low-intensity level and progress at a slower rate. ■

This information is based on a book entitled Health and Fitness Through Physical Activity *by M. L. Pollock, J. Wilmore, and S. M. Fox. John Wiley and Sons, Inc, New York. (In press).*

A supplemental reading list is available upon request from THE PHYSICIAN AND SPORTSMEDICINE.

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Teaching Physical Fitness Concepts in Public Schools

Russell R. Pate

Most physical educators would agree that a major aim of their profession is to promote physical fitness. However, in the typical public school physical education program, students receive a very restricted exposure to physical fitness. Commonly the student's experience with physical fitness is limited to participation in a few fitness activities and undergoing a physical fitness test. In recent years some programs have adopted curricula through which students are systematically exposed to a broad range of lifetime fitness activities. But, tragically, it is only the rarest of physical education programs that ensures that its students develop a thorough *knowledge and understanding* of the *concepts* related to physical fitness. The purpose of this article is to draw attention to this deficiency and to suggest how it could be corrected.

The recent upsurge of interest in physical fitness among adults could be interpreted as a major success for the physical education profession. Certainly it is true that physical educators have helped to initiate and promote the current fitness movement. However, certain aspects of this movement draw attention to a weakness of traditional physical education, i.e., the failure to educate students, in a cognitive sense, regarding physical fitness. Manifestations of this failure abound: the fitness marketplace is filled with bogus exercise gadgets and machines; bookstore shelves are crammed with phony weight-loss manuals; and "figure salons" sell costly memberships to persons who are promised that the "pounds will just melt away." Even among people who select appropriate forms of exercise, a collective lack of knowledge seems apparent. In response, millions of adults have sought fitness information through the print media, and, as a result, publication of exercise books has become a growth industry.

These observations should be of concern to the physical education profession for they prompt the obvious question: why did not the adult population acquire the fitness knowledge it needs in school? At the superficial level the answer to this question is equally clear — information regarding physical fitness has not been taught by physical educators or anyone else in the public schools. The solution to the problem would seem to be straight-forward — let us begin to incorporate into our curricula cognitive material related to fitness.

Analysis of the Problem

At this point one is tempted to launch immediately into a series of specific recommendations. These will come. But, before attacking a problem, it is wise to try to understand it as fully as possible. Thus we should ask ourselves why it is that, during all of these years, we have essentially overlooked the cognitive domain in physical education. I feel that there are several explanations. First, in general, we have not perceived ourselves as having any responsibility in the cognitive area. We have seen ourselves as activity specialists and have not felt compelled to "compete" with other school programs for a space in the cognitive domain. Also, many of us may have doubted our own mastery of physical fitness information and therefore have willingly assigned it to the bottom of the curricular priority list. Certainly we must recognize that there has been no accountability whatsoever regarding the cognitive aspect of physical education. No principals, superintendents, or coordinators have been pushing us to teach fitness concepts, nor have we been evaluated on our effectiveness as facilitators of cognitive learning. And, finally, professional preparation programs should be indicted for their narrow and exclusive focus on the teaching of motor skills. College programs have not taught physical education majors how to teach concepts or how to incorporate material into the physical education curriculum.

Curriculum

If we are to begin dealing with fitness concepts in our physical education programs, the first step is to decide what we are going to teach. That is, we must construct a curriculum. The outline of a suggested curriculum is presented below. The concepts vary somewhat in difficulty of mastery. However, most can be introduced at the elementary school level, expanded upon in the middle school, and dealt with in detail in the secondary school. The outline is not intended to be all-encompassing. On the contrary, it lists only the topics this author feels are the most critical.

Suggested curriculum on physical fitness concepts

I. *Defining Physical Fitness*
   - A. Fitness components — identify and define each
   - B. Health-related fitness components
   - C. Motor fitness (athletic) components

II. *Cardiorespiratory Endurance*
   - A. Definitions
   - B. Benefits
     1. Coronary heart disease risk
     2. Everyday life/physical working capacity, vigor, use of leisure time

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C. Evaluation
   1. Field tests — 12-minute run, mile run
   2. Stress testing
D. Methods of Improvement
   1. Identification of aerobic activities — jog, swim, cycle
   2. Frequency, intensity, duration of exercise
   3. Heart rate, monitoring of exercise intensity
   4. Cooper's "Aerobics" system

III. *Body Composition*
A. Evaluation — skinfolds
B. Health factors related to obesity
C. Caloric balance
D. Weight loss programs
   1. Role of diet
   2. Role of exercise
   3. Weight loss myths
E. Consumer topics
   1. Fad diets
   2. Spot reduction
   3. Long-haul approach vs. rapid loss

IV. *Flexibility*
A. Health factors — low-back pain
B. Evaluation
   1. Sit-and-reach
   2. Kraus-Weber Battery
C. Methods of Improvement
   1. Static stretching techniques
   2. Gymnastic, dance activities

V. *Muscular Strength and Endurance*
A. Role in overall fitness and in athletic performance
B. Health benefits of abdominal strength — low-back pain
C. Evaluation
   1. Bent knee sit-ups, bar dips, flexed arm hang, pull-ups
   2. One repetition maximum — bench press
   3. Handgrip
D. Methods of Improvement
   1. Calisthenics
   2. Resistance training — isotonic, isometric, isokinetic

Teaching Methods

The successful implementation of a curriculum depends on the creation and mastery of appropriate teaching strategies. In the present context this represents a significant hurdle because physical educators often are unaccustomed to teaching cognitive material. Also, we must recognize that the gymnasium, as a physical setting, is not particularly well adapted for traditional "classroom teaching techniques" (e.g., lecturing, reading, workbooks, etc.). In addition, students come to the physical education class expecting action, not talk. These factors suggest that innovative teaching methods must be used. To be sure, specific methods must be created by the individual teacher to suit his or her pesonality and particular teaching situation. However, the following tips for teaching physical fitness concepts are presented for consideration. It is hoped that these suggestions will start the reader's creative juices flowing.

Tips for Teaching Physical Fitness Concepts

1. *Teach the concept through activity.* Whenever possible build cognitive material into the activity setting. This can be done by using role playing, learning centers, and stop actions. There is no substitute for the alert teacher's seizure of the "teachable moment."
2. *Keep lecturing to a minimum.* Students react negatively to the lecture method in physical education. Lecture only when absolutely necessary and only when your students are most likely to be calm and attentive (usually after a period of vigorous activity).
3. *Use audiovisual aids.* Films, slide-tape sets, filmstrips, video tapes, and posters are available and can be used advantageously in the physical education setting. Check with your local health department, Heart Association, and Lung Association.
4. *Develop a physical education library.* A corner of your gym, locker room, or office could be set aside for a reading area. This library can be stocked with appropriate nonfiction and fiction materials. Check with your school librarian on materials that may already be available to you.
5. *Cooperate with science and health education teachers.* You may be able to coordinate certain aspects of your curriculum with the curriculum of other subject matters. Physical education can serve as the lab for certain topic areas in biology and health education.
6. *Require or encourage homework or out-of-class projects.* Who said that classroom teachers have a monopoly on term papers, required reading, and book reports? Also, how about giving credit to students who design and execute a behavior modification project.
7. *Use fitness testing as a cognitive experience.* When administering a physical fitness test, take the opportunity to tell students why they are being tested, what the results mean, how the results will be used, and how the students can improve their performance.
8. *Apply fitness concepts properly in your teaching.* Be sure that the fitness activities you prescribe in class are in concert with the fitness concepts you want the students to master. That is, be sure that the students' practical experiences in class reinforce the proper concepts.
9. *Do not overlook the "how to's" for popular fitness activities.* There is something to learn about jogging (and other fitness activities) — do not assume that everyone knows how to jog, swim, or cycle for fitness.
10. *Plan a long-range, progressive curriculum.* If you systematically plan for the incorporation of cognitive material into your curriculum, a large amount of information can be disseminated using only 3–4 minutes per individual class period.

Note:

$$\frac{3 \text{ min.}}{\text{class}} \times \frac{2 \text{ classes}}{\text{week}} \times \frac{40 \text{ weeks}}{\text{year}} \times 10 \text{ years} = 2{,}400 \text{ min. } (40 \text{ hours})$$

Conclusions

To summarize, it seems clear that traditional physical education has overlooked the cognitive domain. The result is that students have graduated from our public schools essentially uneducated regarding the concept of physical fitness. The solution to this problem lies in the implementation of physical education curricula that recognize the cognitive

domain as coequal with the affective and psychomotor components of education. At present, such programs are being successfully instituted by a smattering of individual teachers who recognize the importance of cognition in physical education and who are stimulated by the challenge to create a unique teaching method. It is hoped that the number of such teachers will increase rapidly enough to ensure that the next generation that passes into adulthood will do so having been, in a comprehensive sense, physically educated.

Note: A video tape entitled "Methods for Teaching Fitness Concepts" is available through the AAHPERD/NASPE Media Resource Center. This tape shows physical educators in the actual practice of teaching physical fitness concepts to students at the elementary, middle, secondary, and college levels. A copy of this tape may be obtained by sending a blank tape (¾ in., 60-min. cassette) to the following address:

AAHPERD/NASPE Media Resource Center
College of Health and Physical Education
University of South Carolina
Columbia, SC 29208

Teaching Health-Related Fitness in the Secondary Schools

Charles B. Corbin

In 1977, a Gallup poll indicated that twice as many American adults were participating in recreational exercise as were participating in 1961. Many, if not most, of the activities in which they participated were aerobic in nature. This should be encouraging news for educators for the data suggest that our programs may be effective in promoting these changes in behavior. However, a closer look indicates that our programs may not be responsible for the shift in activity patterns of Americans.

It seems that the most effective efforts to promote health-related physical fitness, including cardiovascular fitness, which is the most direct byproduct of aerobic exercise, have come from outside physical education rather than from within. While medical doctors and journalists are spearheading the movement with books on the best-seller list and best-selling magazines, many physical educators are content to continue with their "sports as usual" programs. As George Sheehan noted, "there is a physical fitness and exercise bandwagon going on in our country; unfortunately the parade is passing physical education by." This is not to suggest that the purpose of physical education in the secondary school is exclusively physical fitness, but it is to suggest that physical education should consider some significant changes if it is to play a significant role in the future of public education.

This particular article focuses on teaching the health-related aspects of physical fitness, namely, cardiovascular fitness, strength, muscular endurance, flexibility, and body fatness. There are several good reasons why these aspects of fitness should be emphasized. First, they are important because those who possess them are less likely to have hypokinetic diseases than those who do not possess them. This is not true for the skill-related aspects of fitness.

A second reason for emphasizing the health-related aspects, as opposed to the skill-related aspects of fitness (agility, balance, coordination, power, reaction time, and speed), is that *all people*, regardless of ability, can benefit from regular programs designed to promote these health-related components. On the other hand, there is a limit to the amount of improvement possible for many people when it comes to skill-related fitness. The principal value of skill-related fitness is improvement in sports and other skills. It may just be that many persons feel that there is a limit to what can be gained from repeated exposure to programs that focus on skill-related fitness. Yet in most schools emphasis is placed on skill-related fitness. This is not to suggest that skill improvement is not important; indeed it is. However, these are *not* the only programs of importance to students in physical education classes.

In addition to teaching sports and other motor skills, a need exists for more emphasis on the health-related aspects of fitness in school programs. As noted earlier, it is in activities designed to improve health-related fitness and in activities that do not require great amounts of skill that Americans have taken a great interest. These are the lifetime activities that we must *teach* about rather than *talk* about. As evidence, consider the fact that 63 percent of Americans interviewed concerning the value of their physical education experience 25 years after their formal schooling felt that what they learned in physical education class was of little value later in life (Brunner 1969). A recent Gallup poll on American education (1978) did not list physical education in the top 10 subjects rated for their usefulness in later life, though extracurricular activities including sports, drama, and band were rated in the top group. Apparently the lack of importance associated with physical education has resulted in deletion of physical education classes in some secondary schools across the country as evidenced by the fact the National Association for Sports and Physical Education felt the need to establish a "Save Physical Education Task Force" to help prevent such erosion.

The development of the Health Related Physical Fitness Test is a step in the right direction toward improving health-related fitness, but testing it is of little value if we do not implement programs designed to teach for it. We must not go back to the old physical training of "PT" programs designed to force improvement in fitness. That would do little more than teach students how to hate physical activity and exercise. Fitness is important, especially health-related fitness, but sound educational programs must consist of more than exercising and achieving fitness.

Some years ago I developed a taxonomy of objectives (Corbin 1976; Corbin 1978) that ranked these objectives from low to high in importance (see Table 1).

Table 1
A Taxonomy of Physical Fitness Objectives

1. Physical fitness vocabulary
2. Exercising
3. Achieving fitness
4. Patterns of regular exercise
5. Evaluating physical fitness
6. Fitness and exercise problem solving

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All of these objectives are important. The point is that when lower-order objectives have been met, our job is not done. It should be our purpose to help *all* people achieve *all* levels of objectives including those of the highest order.

As seen in Table 1, exercising and achieving fitness are relatively low-order objectives. They are important, but we should not sacrifice higher-order objectives in meeting these. I think specifically of the teacher who runs mass calisthenics, and uses physical exercises as punishment. Students may achieve fitness in doing these things but they also may choose not to exercise later in life because of these experiences. Further, as they do exercise, students may learn little about *why* they are doing what they are doing. They may "get fit" for the short term but may learn little that will be used over the long haul.

In recent years colleges and universities have implemented courses called lecture-lab or concepts approaches to physical education. For convenience, they will be called concepts programs for the remainder of this article. These programs focus on the higher order physical fitness objectives. Listed below are three basic purposes claimed for these programs (Corbin and Laurie 1978).

Why. One purpose is to help students learn that health-related fitness is important. Learning the *why* of physical fitness and exercise is necessary as part of the process of learning to solve personal exercise and fitness problems.

What. A second purpose is to help students learn *what* their fitness needs are. Evaluating fitness is a higher-order objective and something people must be able to do if they are to become effective problem solvers.

How. The third purpose is to help students learn *how* to exercise correctly. There is a correct way to exercise. To learn the value of specific exercises is essential to developing patterns of regular exercise and solving exercise problems.

Concepts programs have been most successful at schools such as Kansas State University, Mercer County Community College, the University of Toledo, Missouri Western University, and Oral Roberts University to name but a few. But why wait until college? Are secondary school students not capable of learning higher order physical education objectives? Indeed they are! It is my opinion that the *what, why,* and *how* of physical activity are best taught in our junior and senior high schools.* The college programs are remedial and necessary only until secondary schools have shown that they are effectively helping students meet higher-order objectives.

Already many junior and senior high schools have implemented the concepts approach in their curriculums. Some unusual features of the programs instituted in the programs at these schools are listed below. Many of these features represent significant departures from normal operating procedures used in physical education.

Lecture or Class Discussions. In this type of course some class periods or part of certain class periods are devoted to lectures, class discussions, films, or slide presentations designed to teach the facts about fitness and exercise.

Textbook. A textbook is used to supplement the information given in class concerning fitness and exercise and to provide self-evaluation as well as sample exercise program information. These materials present information that can be used for a lifetime.

Self-Evaluations. To help students better understand their own fitness needs much time is spent in the self-testing of health-related and skill-related physical fitness.

Sample Exercise Programs. Many different exercise programs are tried out, including such formal programs as aerobics and the West Point program; informal programs such as jogging and rope jumping, and sports of all types.

Experiments. Students do experiments to help them discover information about fitness and exercise. Examples are experiments designed to help students learn the correct way to exercise and experiments designed to locate personal thresholds of training.

Different Grading. It is important that grading *not* be based on low order fitness objectives such as achieving fitness. If higher order objectives are the concern, current levels of fitness based on personal fitness tests should *not* be the basis for grading. For suggestions on grading refer to the following reference (Corbin and Lindsey 1979a).

Planning a Personal Fitness and Exercise Program. The culminating activity for the concepts class is the development and implementation of an exercise and fitness program that can be used for a lifetime.

Different Topics. Some of the topics of the course are quite different from those normally covered in a physical education class. A sample from one secondary school concepts textbook is listed below (Corbin and Lindsey 1979b):

- Fitness for all
- Parts of fitness
- Threshold of training
- Cardiovascular fitness
- Strength
- Muscular endurance
- Flexibility
- Exercise and fat control
- Exercise and good health
- Skill related fitness
- Correct way to exercise
- Physical activity for a lifetime
- Fitness through sports
- Planning your exercise program
- Attitudes about fitness

The schools that have tried the concepts-type program at the high school and junior high school levels find there are at least three different organizational structures that seem to work well (Corbin 1978). Because each school has its own unique needs, the best approach for a given school will vary. The organizational approaches and suggestions for each are listed below (Corbin 1978; Corbin and Lindsey 1979a).

The Unit or modular approach. This is the approach used in most colleges. It seems to be most effective in schools with students of relatively high achievement orientation. In this approach a specific period of time is set aside, 6 weeks, 9 weeks, a semester, or a full year, exclusively for a concepts unit or module.

The integrated approach. This approach merely integrates the what, why, and how into the regular physical education program. On specific days concepts material in the form of lectures, discussions, films, slides, self-evaluations, experiments, and sample exercise programs are used. On other days material from the more typical skill-oriented program is

*Actually we must begin to meet these objectives in the elementary schools. This reference simply means that even the highest order objectives can be met by the students in our secondary schools.

presented. This program seems to be quite effective for large schools and those which have been more traditional in their orientation prior to introducing the concepts approach. One highly successful integrated program is that of Topeka West High School in Topeka, Kansas.

The mini lecture approach. This is a modified form of the integrated approach. The essential difference is that at no time is a full class period used for lecture or discussion. Rather, short segments of several periods are used for mini lectures or short presentations concerning important exercise and fitness topics. This approach seems most effective in schools in which students are lower in academic orientation than in the typical school.

As noted very early in this paper, the concepts approach to teaching higher order exercise and fitness objectives is not meant as a substitute for more traditional skill-oriented programs. It is meant to complement and supplement sound programs of lifetime sports. For those persons who implement the program there appear to be several important advantages.

Accountability. In this age of cutbacks in spending, physical education programs in many schools are under attack. Apparently this is partly because many adults do not feel that physical education has much value for a lifetime. The concepts program offers physical educators the opportunity to become accountable for significant higher order objectives. Indeed, it offers physical educators the chance to *lead* the exercise and fitness parade rather than allowing it to pass them by.

Coeducational Instruction. The concepts approach is and should be coeducational. In life, people exercise corecreationally, and this is as it should be. The well-planned concepts class more than meets the guidelines of equal opportunity legislation such as Title IX.

Education for All People. The concepts program can easily be adapted to meet the needs of all kinds of special people including the physically handicapped. Perhaps more importantly, it can meet the needs of those people whom Roberts (1977) labels as having "learned helplessness." These people feel that exercise, sports, and physical activity are not for them. They say, "I'm no good, physical education is for the jocks, not for me." The concepts course can *help all people learn that there is some form of exercise for everybody.* (Incidentally, one good reason for *not* grading on fitness test scores is so as not to discourage those persons who already feel exercise is not for them.)

The concepts approach to physical education is not a cure for all of physical education's problems nor is it guaranteed to work in all situations. No program can be better than the people who teach, organize, and administer it. There is, however, evidence that this type of program that focuses on the health-related aspects of fitness, can be an effective program for helping American youth learn to exercise and be fit for a lifetime.

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The Hope-Kellogg Health Dynamics Program

Richard A. Peterson

Hope College is a modest-size undergraduate liberal arts college located in Holland, Michigan. Characteristics that distinguish Hope College are its affiliation with the Reformed Church in America and a disproportionate number of students of Dutch ethnic background. Hope enjoys a superb academic reputation, particularly in the sciences. Its mission is to be influential in the development of the total person through a liberal arts education within the context of the Christian faith.

Hope recognizes that such a mission includes not only providing the finest possible education for the mind and a conducive atmosphere for the development of the spirit but also includes the best possible opportunities for the development and care of the physical self. Therefore, Hope College has always offered abundant opportunities in physical education and athletics.

Recent trends in American culture indicate that individual well-being may not be taken for granted. The physical demands of modern life are so minimal that a crisis of physical health would be unavoidable without nonessential physical activities. Many persons believe that such a crisis of physical well-being would have inevitable consequences on mental and spiritual health and would decrease society's availability of human resources. Current programs of health and physical education appear to have an obligation to meet this challenge in the most appropriate ways.

In addition to the decrease of physical demands in modern life, rather dramatic changes have occurred (1) in diet, where man seems more intent on eating for pleasure and social conformity than for health, (2) in emotional stresses and tensions, where fast pace and aggressive ambition appear to overpower perceived needs for rest and relaxation, and (3) in many other areas of life-style, where following lines of least resistance or the wish to comply with cultural convention have reduced health concerns to low priority. Programs concerned with the health benefits of physical activity seem remiss if they do not address these other interrelated aspects of life-style.

The Hope-Kellogg Health Dynamics Program represents Hope College's response to this need for innovative approaches to health and physical education. Those in charge are convinced that a strong relationship exists between life-style and health, and they are committed to providing for the physical health and fitness needs of the individual. The program combines, in a unique and innovative way, certain endeavors of the Physical Education Department, the College's Health Clinic, the Food Service, and the Office of Student Personnel Services to provide a comprehensive program of health and physical education, health care, and health promotion and advocacy.

Early on, in the conceptual stages of program development, the challenge of how best to fulfill this mission became apparent. College, viewed as a stage of life, exhibits many interesting, but often conflicting, characteristics. It represents a time when young adults are learning, questioning, analyzing, and making many decisions about their futures. Conversely it is often a time for indulging adolescent dreams about the good life within an atmosphere of new freedoms from restraint. It is often unpredictable which way the group psychology will react to new approaches to old subjects.

This is particularly true when one of the major objectives of the new approach is to affect actual health behaviors. College students have lived in mainstream American culture for many years; habits, attitudes values, and priorities have largely settled in. Although the recommended life-style is not radically or dramatically different from the current cultural norm, still conscious, willful effort would be required to adopt changes, to overcome the inertia of life-style by habit, and entrench new patterns of life that are oriented at least obliquely to those most commonly followed.

On the other hand, college represents a period of flux in personal behavior for many. Persons experiment with life-styles that are perceived as chic and attractive according to the "Madison Avenue" model. Such images, often conflict with both their role as serious students and with guidelines for healthful living patterns.

Thus a general pattern emerges that seems to hold more often than not within our society. Individuals learn and entrench a life-style as children, depart from that life-style briefly in young adulthood, and then return gradually to roughly the same life-style that was learned while growing up, with appropriate variations to account for changes in society at large. During this process, little thought is directed towards health and fitness and particularly towards the role of life-style in these important life qualities.

All of this takes place within an atmosphere of a societal preoccupation with matters of health. It would appear a logical paradox that so much stress is placed on health information in our culture yet only a small proportion of the population follows life-styles that really promote health, wellness, and fitness.

One of the first steps that a program must take if it is to be effective in influencing behavior patterns is to arouse the

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personal interest of the individual in his or her own health; to develop a conscious curious awareness so that learning, analysis, and decision-making may take place in a receptive environment. Certainly many educational strategies are recognized as effective in arousing interest. The challenge is to optimize the effectiveness of these techniques while minimizing obstacles to interest arousal as well as minimizing the generation of resistive interest. This was our intent when we began to establish the detailed plans for the accomplishment of our purposes. What follows is a description of the salient features of the Health Dynamics Program at Hope College.

Initial Health Screen

Prior to arrival on campus, each student completes an extensive questionnaire covering health history, health habits, self-image, and current health status. Upon arrival, further information is gathered about health and fitness knowledge, attitudes, values, and priorities. This information is reviewed by Health Clinic staff and program personnel for potential problems or concerns. If such problems surface, the program provides appropriate attention to the concern. Those who have no apparent problems proceed into the basic freshman year experience.

In each case, careful note is taken of the information gathered. Those who have no apparent problems should not feel that there is no interest in their situation. Health information gathered, regardless of source, is summarized in several ways so that each student has an expanding personal health profile that may be added to and which forms the basis for the development of a personal health action plan. Since no two profiles are alike, no two health action plans could be the same. In this way individualization is achieved both in the process and the product.

Academic Component

One of the components of the freshman experience is academic in nature. The basic concepts of the relationships among exercise, diet, fitness, and health are explored. Such knowledge may be obtained through lectures, reading, media and/or other tools typical of the academic approach. Discussion is also encouraged through the use of discussion questions. Discussion is uniquely able to provoke personal thought involvement. Thus this component is expected to both inform and arouse interest.

Health information has increased in a nearly explosive fashion in recent years. There are probably many reasons for this, but it seems likely that the trend towards a more individualistically oriented society is strongly involved. In such an atmosphere, factual, accurate information is mixed with generous proportions of myth, partial truth, conjecture, and opinion in such a way that the individual exploring the milieu is often confused and frustrated. The intent of the Health Dynamics academic component is to not only provide a valid overview of information but also to provide the individual with the necessary analytic tools so that he may do his own literature resolution.

Assessment Component

A variety of assessments that have meaning for health and fitness are conducted during the freshman program. Testing is done in the exercise biology laboratory. Each student is given a graded exercise tolerance test on a bicycle or treadmill ergometer. Heart rate, blood pressure, and energy output level are monitored throughout. Each student also is hydrostatically weighed to determine body composition. Tests of pulmonary function, flexibility, strength, and power are also given in order to obtain a fairly comprehensive physiological fitness profile.

In addition to these laboratory tests, assessments of health-related behaviors are made. Persons are asked to record periodically behaviors such as diet, physical activity, alcohol and tobacco use, stress perception, rest, and bouts of illness. When the biologic functions and behavior information are added into the previously mentioned personal health profile, a composite emerges that includes health history, current health and fitness status, health behaviors, and health knowledge, attitudes, values, and priorities. The profile is characteristic of each person and when dealing with the profiles, an individual approach seems most appropriate.

Advising Components

Such a profile, although interesting from a "this is me" standpoint, is of little value unless made meaningful through some form of follow-up, explanation, and, where appropriate, recommendations for change. We do this by meeting with each student, getting to know him as a person as well as a profile, and giving him an opportunity to know us. In order to improve the program staff/student ratio, upper-division major students are enlisted to augment our staff. During the meeting, we share the meaning of the student's profile with him and explore the areas where change might be helpful. Although a one-on-one component such as this might not be possible everywhere, we feel it is one of the major strengths of our program.

Prior to this meeting, each student prepares a document that we label a "personal health action plan." This document summarizes the personal health profile by pointing out areas of health strengths and weaknesses and also allows the person to voice feelings about plans for reinforcing strengths and accommodating weaknesses. The preparation of such a document has several advantages. It certainly improves the efficiency of the meeting; more gets done in less time. It also has tremendous value as a tool to focus on one's physical self. Additionally, it provides a framework for personal education to take place about health and fitness concepts. Thus, even if the person hasn't the inner resources to actualize his plan, it has had value in accomplishing something significant for him.

Physical Activity Component

Each student participates in physical activities in accordance with the implications of his individual profile and in accordance with the particular goals and objectives he has expressed to us. The objectives of the physical activity are to provide activities strenuous enough that a training effect takes place, are enjoyable enough that the student perceives them as a positive experience, are in accordance with the principles of fitness for health, and are effective in laying the foundation for a lifetime of healthful exercise. Such goals certainly require not only selecting the appropriate activities, but also the correct teaching methods, philosophies, and attitudes. These, of course, must be mutually understood beforehand and adhered to.

The components described above are effectively handled within the context of college coursework. One of the more unusual features of the program, however, is what happens in

the broader campus community. We don't believe that a true impact will take place in students' lives unless a conducive atmosphere or environment exists; the college must be with us in spirit and in action. Campus personnel not directly involved in the program must provide modeling and vocal support, not just to enhance the program but because they actually believe in what they are doing. Thus we direct efforts to the campus at large.

One campus activity that impacts strongly on health is residence hall dining. More than 75 percent of Hope's students dine on campus. We feel that this should be a healthful experience and, to that end, we have developed working relationships with the food service and the students. The food service provides meals that conform to health nutrition guidelines, complete nutrient analysis of all items served, and a dietitian consultant to answer questions and provide basic nutrition information. It also provides for the special needs of dieters, vegetarians, and others for whom the basic diet is not appropriate. Student committees are formed under the auspices of the Health Dynamics Program to advise the food service, to observe the eating habits of the students, and to serve as a link between the program and the students. The program provides basic nutrition education so that students are aware of health nutrition guidelines.

The role of the college's health service in initial screening has already been mentioned. The integration of the program with the Health Service goes beyond that, however, to a real partnership in caring for the health of Hope students. Cross-referrals are immediate whenever appropriate and a team approach to both preventive and restorative health care assures the student that his health concerns are important. Even in physical setting, the integration of these services is apparent. The Health Clinic, the Physical Therapy/Training Room, and the Exercise Biology Laboratory are all situated in the same complex and are interconnected.

One intangible factor that may not be left to chance is the attitude of the campus community. Fostering a higher visibility of health and fitness related concerns on a campus-wide basis is principally a public relations and communications task. The more students and faculty know about philosophies and intentions of the program as well as the actual implementation strategies, the more likely they will be to retain a supportive mind set. Such amenities as newsletters, fitness testing and consultation, and ready access to facilities go a long way toward entrenching positive feelings about health and about the program.

Conclusion

We feel strongly that "health dynamics" is an idea whose time has come. Medicine is moving towards more emphasis on preventive approaches; health education is focusing more energy on the importance of life-style in health; and physical education is increasing its endeavors in health and fitness related activities. Health dynamics exists where these disciplines intersect. Health dynamics means doing something personal, positive, and appropriate about promoting one's own health, wellness, and fitness. The program at Hope College is designed to offer a means for such promotion.

The Aerobics Program at Oral Roberts University

Paul Brynteson

When a health and physical education (HPE) program becomes a part of a college or university curriculum, it implies that the program has some reason for being, some purpose, some goal, some objectives. Too often HPE programs have been hazy in articulating those goals and purposes and when called upon to defend why their program should be required as part of the university curriculum, educators have often been unable to do so. The evidence is that in 1968, 87 percent of colleges and universities required physical education. In 1972 this had dropped to a 74 percent requirement, and by 1977 the requirement had further dropped to 57 percent of the colleges and universities requiring physical education.

I believe a significant reason for this trend has been the lack of direction by health and physical education programs. At ORU we have made a definite attempt to clearly describe the purpose of the HPE program and relate it to the overall purpose of the university.

Philosophy of Oral Roberts University

Oral Roberts University has a required HPE program for three reasons. In the *first* place, it is consistent with the philosophy of the university. The founding philosophy of ORU is to provide an education that seeks to develop the whole person with equal emphasis on mind, spirit, and body. The college catalog states that ORU wants its graduates to be "mentally alert, spiritually alive, and physically fit." ORU seeks to develop a lifestyle in its students conducive to the development of the whole person. President Oral Roberts, founder of the university, has said, "ORU is a lifestyle in which an education takes place."

Paul Brynteson is a professor at Oral Roberts University

When we think of the "education of the body" we think of the health and physical fitness of the body and the development of life-style patterns that will enhance the health and physical fitness of the body. The development of the body is not an end in and of itself; rather it is a means to an end. It is through a healthy and physically fit body that the mind can function at its peak and the spirit can have freedom to direct the whole person so as to be an effective, functioning member of our society.

As an implementation of that philosophy the Health, Physical Education, and Recreation Department at ORU has the responsibility for implementing the physical fitness goals of the university. Therefore, a requirement in HPE is totally consistent with the goals of the university.

The *second* reason why ORU has an HPE requirement is for medical and health goals. One major health problem in the United States today is cardiovascular disease. Research has identified the various factors that are related to this disease. Some of these are:

1. Factors *we can't control* such as sex, age, and heredity.
2. Factors for which *we need medical assistance to control* such as hypertension, diabetes, and hyperlipidemia.
3. Factors *we can control* such as smoking, obesity, diet, and physical activity.

It is because we know that we can control some of the factors relating to this debilitating disease that HPE is required at ORU. We believe that the education received will enable our graduates to better control the factors relating to the disease, and thus reduce its incidence.

The *third* reason for the HPE requirement at Oral Roberts University is a spiritual one. We believe the Bible teaches that man is the temple of God and that as the temple of God we're to take care of our bodies because the Spirit of God dwells within our bodies (I Corinthians 3:16-17 and 6:19-20). Therefore, we are not to abuse our bodies. The goal of our HPE program is to educate our students on how to take care of their bodies.

Administration of ORU's Aerobics Program

On the basis of the philosophy just outlined and our knowledge about health factors related to various diseases, the Health, Physical Education, and Recreation Department, together with the Human Performance Laboratory and the Student Health Services, has developed a health and physical fitness program directed toward controlling those factors we can control. The following charts indicate the administrative structure of the ORU aerobics program as well as the responsibilities of the HPER Department, the Human Performance Laboratory, and the Student Health Services as we work together to direct the aerobics program. (ORU in 1983-84 had 4,000 undergraduates and 800 graduate students. It has 8 schools — Arts and Sciences, Law, Medicine, Dentistry, Nursing, Business, Theology, and Education.)

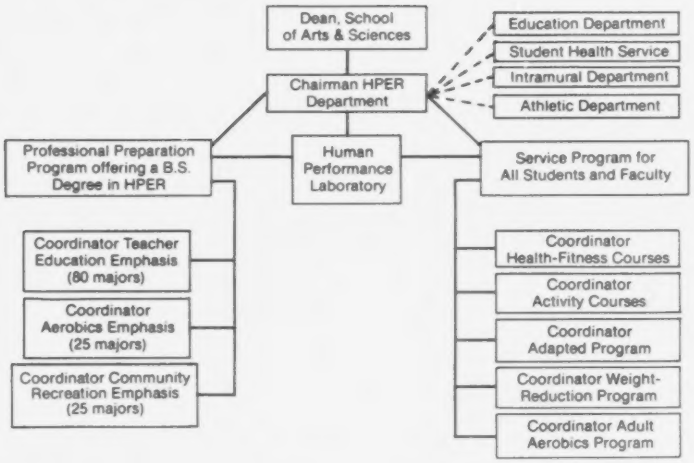
Responsibilities

HPER Department. To provide the Aerobics Instructional and Physical Activity Program.

Student Health Service. To medically clear all students for exercise and make modifications in requirements for persons needing adaptations. These may be temporary or permanent.

Human Performance Laboratory. Provide support services to the HPER Department and the Student Health Services in terms of administering blood

Organization of the HPER Department


Dean, School of Arts & Sciences
Education Department
Student Health Service
Intramural Department
Athletic Department
Chairman HPER Department
Professional Preparation Program offering a B.S. Degree in HPER
Human Performance Laboratory
Service Program for All Students and Faculty
Coordinator Teacher Education Emphasis (80 majors)
Coordinator Aerobics Emphasis (25 majors)
Coordinator Community Recreation Emphasis (25 majors)
Coordinator Health-Fitness Courses
Coordinator Activity Courses
Coordinator Adapted Program
Coordinator Weight-Reduction Program
Coordinator Adult Aerobics Program

pressures, anthropometric tests (weight, skinfolds, and hydrostatic weighing), and cardiorespiratory fitness tests (treadmill, bicycle ergometer, or arm crank).

Purpose of the HPER Department

The purpose of the Health, Physical Education, and Recreation Department is to provide an atmosphere for understanding and appreciating the relationship of physical activity and fitness to optimal lifelong health and well-being so that the individual will select an appropriate personal lifestyle reflective of the whole person that Christ intended. The service program aims to accomplish this purpose for students and faculty at ORU. The professional preparation program aims to prepare professionals who can accomplish this purpose in schools, churches, YMCA's, recreation centers, businesses, industry, and similar settings.

University HPER Requirement

The aerobics component is a part of all health, physical education, and recreation-activity courses. The following are requirements all students must follow:

1. All full-time undergraduate and graduate students must enroll in and pass an HPER activity course every semester. Failure to do so may result in suspension from the university.
2. Course sequence:

Fall Semester

Freshman	Health Fitness I
Sophomore	Elective Activity
Junior	Elective Activity
Senior	Elective Activity
Graduate Students	Elective Activity

Spring Semester

Freshman	Health Fitness II
Sophomore	Elective Activity
Junior	Elective Activity
Senior	Elective Activity
Graduate Students	Elective Activity

3. No full-time student is exempt from participation in the HPER activity courses for any reason. A student with a medical problem will participate in a modified aerobics program. It is the student's responsibility to see the university physician who will prescribe a special exercise program and to communicate this to his or her instructor.
4. Students who are not fulfilling ORU's physical fitness requirements will be placed on physical probation or suspension. A student's progress will be evaluated at the end of each year and he or she will be placed on probation or suspension for (1) failing an HPER activity course, (2) failing to enroll in a specific activity class or classes as required by the HPER Department, (3) failing to report to the Human Performance Laboratory or the Student Health service as required by the HPER Department, (4) failing to make satisfactory progress in physical-fitness criteria as prescribed by the HPER Department and the university physician.

Health Fitness I and Health Fitness II Courses

The purpose of these courses is to provide information in the form of lectures and laboratory experiences that the students can understand and develop a personal appreciation for the relationship of physical activity and fitness to health. As a result of this understanding and appreciation, we trust that the student will select an appropriate personal lifestyle necessary to produce optimal lifelong health and well-being. The emphasis in the first course is on the concept of lifestyle, health, and physical fitness, the cardiorespiratory system, and nutrition and body composition. The emphasis in the second course is on the musculoskeletal system, a discussion of concepts related to health fitness such as quackery, smoking, and a practical experience for all the students to be certified in cardiopulmonary resuscitation (CPR).

The general goal of the course is that students should be able to answer the following questions:

General Questions

1. What is fitness?
2. How is fitness assessed?
3. How is fitness achieved?

Personal Questions

1. What is my level of fitness?
2. How much fitness do I need?
3. How much fitness do I want?
4. How do I achieve and maintain that level of fitness?

The students will be graded on the basis of four criteria in Health-Fitness I. A minimum standard must be achieved for each criterion to pass the course. The criteria are as follows: (1) knowledge as measured by tests and assignments equals 60 percent of the grade; (2) physical activity as measured by aerobics points equals 20 percent of the grade (the minimal standard to pass the course is an average of 15 aerobics points for men per week and 10 for women); (3) cardiorespiratory fitness as measured by the field test equals 10 percent of the grade (the minimum standard to pass the 1½-mile run for men and 1.25-mile run for women is 14:00 minutes for under age 30, 14:30 for 30–39, 15:15 for persons 40–49, and 16:15 for persons over age 50); (4) body-composition fitness as measured by percent fat equals 10 percent of the grade (minimum standard to pass the course is 26 percent fat for men and 36 percent fat for women).

The students are graded on the same criteria for Health Fitness II; however, the standards are slightly changed. The criteria are as follows: (1) knowledge — 40 percent of the grade; (2) physical activity as measured by aerobics points — 30 percent of the grade (minimum

standard to pass the course is 20 aerobics points per week for men and 15 for women); (3) cardiorespiratory fitness is measured in two ways — in the first place the field test is administered and the minimum standard to pass the course is 13:30 minutes for those under age 30, 14:00 for 30–39 age group, 14:45 for 40–49 age group, and 15:45 for age 50 and over. In addition, students must meet minimum requirements for the 3-mile run. The minimum standards are 30:00 for men under age 30, 33:00 for 30–39, 36:00 for 40–49, and 40:00 for ages 50 and over. Three minutes are added to the standards for women. In place of the 3-mile run, students may elect to swim 1,100 meters or cycle 6 miles with the same time standards applied as the 3-mile run. (4) Body composition is measured by percent fat — 10 percent of the grade. Minimum standard to pass the course is 24 percent fat for men and 34 percent fat for women.

During the first two weeks of Health Fitness I, all new students are medically evaluated to determine their current health status by the Human Performance Laboratory and the Student Health Services. We do not require an entrance medical examination but rather test our students on (1) personal health history, (2) family health history, (3) resting blood pressure, (4) physician's heart-lung examination and (5) anthropometric measurements including skinfolds, weight, height, and percent fat.

After the student has completed these tests, the results are fed into a computer and a printout summarizes the results of the tests and clears the student for exercise or indicates that the student is not cleared for exercise. A student not cleared for exercise will be required to return to the Student Health Services for further evaluation. This further evaluation may include a graded exercise ECG treadmill test, blood tests, or other tests that the physician deems appropriate. As a result of the additional tests, if necessary the student will be given a modified activity and physical fitness requirement and this will be communicated to his or her instructor.

Once the student has been completely cleared for exercise with or without modifications, the physical-activity portion of the health-fitness course begins. The basic structure of the health-fitness course is that the students meet once a week for 2 hours. The first hour of the course is in a classroom where a video cassette television tape is shown by the instructor which presents cognitive materials over various topics. Most of the video cassettes are approximately 20-30 minutes in length. At the completion of the tape, the instructor will lead the students in a discussion of that tape and introduce the laboratory session that is to follow. In most cases the laboratory session complements the tape.

The second hour of the health-fitness course then is a laboratory phase where the students normally go to an exercise area, most often the track. It is here that the instructor will lead the students in developing a health-fitness lifestyle.

During the health-fitness course, fewer than 1 percent of the students do not meet the physical fitness standards that have been established by the university. In most cases, students who have difficulty achieving these standards are those who are significantly overweight. A special program is available for students who cannot achieve the body composition standards. Students enroll in HPE Exercise and Weight Control that meets 5 days per week for 1 hour of low intensity exercise (walking/stationary cycling). In addition, they receive counseling in nutrition and behavior modification. Rather than requiring them to meet a specific body composition standard, they must lose a minimum of 8 pounds and 1 percent fat per semester.

Elective Activities

Students who successfully complete the Health Fitness I and Health Fitness II courses take elective individual or team activities the rest of their time at Oral Roberts University. Some of the activities offered include:

Advanced Lifesaving
Archery
Baseball
Body Conditioning
Cycling
Fencing
Flag Football
Intermediate Swimming
Korfball
Recreational Aquatics
Skin Diving
Tennis
Varisty Sports
Wrestling
Snow Skiing
Long distance running
Backpacking
Basketball
Bowling
European Team Sports
Field Hockey
Golf
Racquetball/Handball
Self-Defense
Soccer
Track and Field
Volleyball
Aerobics for Graduate Students
Pickleball
Badminton
Beginning Swimming
Cheerleading
Exercise and Weight Control
Gymnastics
Karate
Recreational Activities
SCUBA Diving
Softball
Trampoline & Tumbling
Water Safety Instruction
Self-Defense
Ice-Skating

The basic objective of all elective activities is threefold: (1) health fitness, (2) recreation skill, and (3) social participation. Students are graded according to these main objectives:

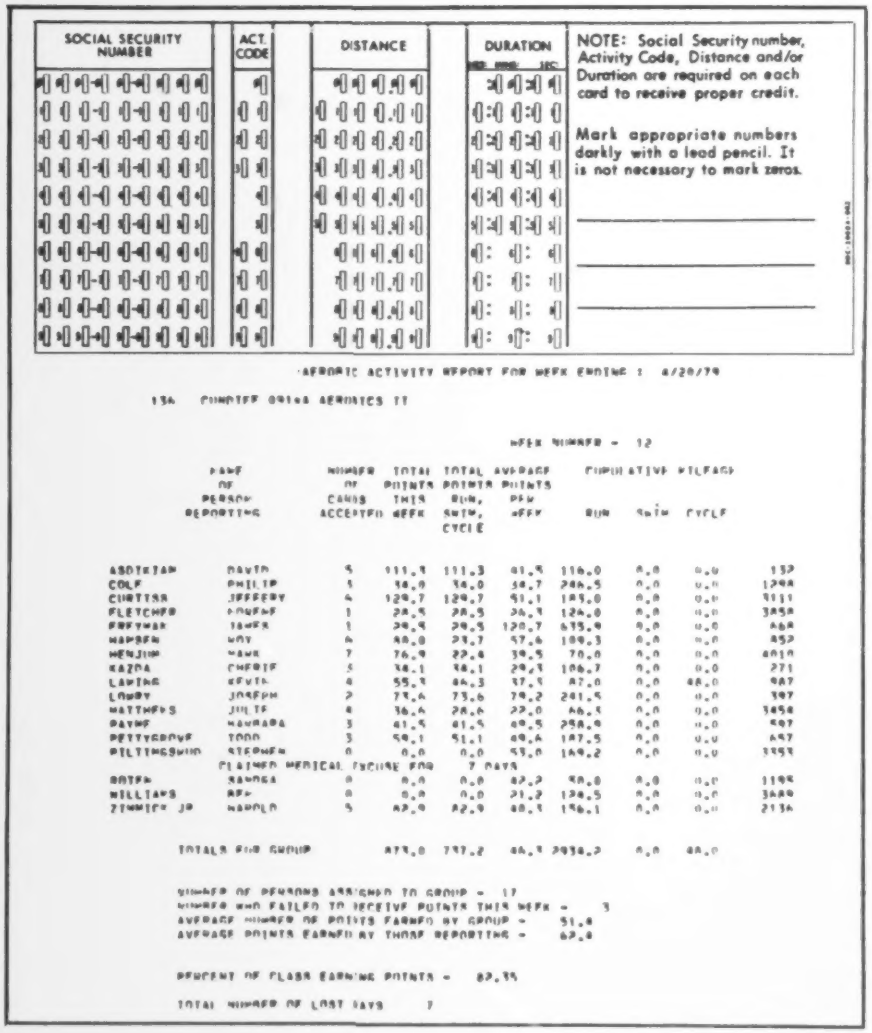
Health Fitness		50%
As Measured by Aerobic Points	30%	
As Measured by Field Test	20%	
As Measured by percent fat	0%	
Recreational Skill		40%
Social Participation		10%
		100%

Although the activity course will be 50 percent graded on health fitness, the total class will be devoted to developing the recreational skill of the course. The students earn aerobics points on their own time and fill out a computer card every time they exercise, turn it in to a box and each week the instructor receives a printout back for the aerobics participation of all students (see sample printout).

The 3-mile field and body composition tests are given once during the semester. Therefore, in a 15-week semester, 14 weeks will be devoted to instruction in the activity and one class period will be devoted to health fitness education. The minimum standards as established in Health Fitness II must be achieved to pass all activity courses.

Results of the Aerobics Program

The results can be presented in various forms and in numerous terms, but let me present results in terms of attitudes



SOCIAL SECURITY NUMBER	ACT. CODE	DISTANCE	DURATION HRS MINS SEC

NOTE: Social Security number, Activity Code, Distance and/or Duration are required on each card to receive proper credit.

Mark appropriate numbers darkly with a lead pencil. It is not necessary to mark zeros.

AEROBIC ACTIVITY REPORT FOR WEEK ENDING : 4/20/79

134 CUMPTER OPTION AEROBICS II

WEEK NUMBER = 12

NAME OF PERSON REPORTING	NUMBER OF CARDS ACCEPTED	TOTAL POINTS THIS WEEK	TOTAL AVERAGE POINTS RUN, SWIM, CYCLE	AVERAGE POINTS PER WEEK	CUMULATIVE MILEAGE RUN	SWIM	CYCLE
ABDIKIAN DAVID	5	111.1	111.3	81.5	116.0	0.0	0.0	132
COLE PHILIP	5	56.0	56.0	56.7	248.5	0.0	0.0	1248
CURTISS JEFFERY	4	129.7	129.7	91.1	183.0	0.0	0.0	1111
FLETCHER DWAYNE	1	28.5	28.5	34.1	124.0	0.0	0.0	3858
FORTNER JAMES	1	28.5	28.5	120.7	615.0	0.0	0.0	468
HARPER WAY	4	88.0	29.3	57.4	198.3	0.0	0.0	852
HENSON MARK	7	76.9	22.4	39.5	70.0	0.0	0.0	4010
KAZDA CHERYL	5	56.1	56.1	29.1	106.7	0.0	0.0	271
LAMING KEVIN	4	55.1	44.3	17.1	87.0	0.0	48.0	987
LOWRY JOSEPH	2	77.4	73.6	79.2	241.5	0.0	0.0	387
MATTHEWS JULIE	4	76.4	28.6	22.0	86.5	0.0	0.0	1458
PAYNE HOWARD	3	61.5	61.5	69.5	258.0	0.0	0.0	987
PETTYGROVE TODD	3	59.1	51.1	69.4	187.5	0.0	0.0	687
PILLINGHAM STEPHEN	0	0.0	0.0	53.0	148.2	0.0	0.0	1353
CLAIMED MEDICAL EXCUSE FOR 7 DAYS								
BATES RAMONA	0	0.0	0.0	82.2	98.0	0.0	0.0	1198
WILLIAMS AMY	0	0.0	0.0	21.2	134.5	0.0	0.0	3688
ZIMMERMAN JR HAROLD	5	82.0	82.0	68.3	196.1	0.0	0.0	2134
TOTALS FOR GROUP		873.0	797.2	66.3	2934.2	0.0	48.0	

NUMBER OF PERSONS ASSIGNED TO GROUP = 17
NUMBER WHO FAILED TO RECEIVE POINTS THIS WEEK = 3
AVERAGE NUMBER OF POINTS EARNED BY GROUP = 51.4
AVERAGE POINTS EARNED BY THOSE REPORTING = 62.4

PERCENT OF CLASS EARNING POINTS = 82.35

TOTAL NUMBER OF LOST DAYS 7

and behaviors, since that is what we're trying to influence.

Recently we asked our current students the following two questions: "What contribution did your high school physical education program make towards your knowledge and attitudes about physical activity and fitness?" "What contributions did the ORU HPE program make toward your knowledge and attitudes about physical activity and fitness?" The results are indicated in Table 1.

We've also just completed the analysis of a questionnaire sent to alumni of ORU and two other institutions with very good required P.E. programs but without the aerobics emphasis. In response to the following question, "What contribution did your college physical education program make toward your knowledge and attitudes about physical activity and fitness?" the results are summarized in Table 2.

The above data support the contention that it's not just a required program that is important, but the program must have a health fitness thrust to affect attitudes relating to fitness. The same survey also revealed that since ORU placed the aerobics emphasis in the curriculum, the alumni are more active than the alumni of the other two colleges.

On three separate occasions we have given pre- and posttests after the one semester Health Fitness I course. The

Table 1

Comparison of Contributions of ORU Physical Education Program with High School Physical Education Programs (Percent)

	Very Significant Contribution	High Contribution	Average Contribution	Low Contribution	No Contribution
High School Program	8	10	31	30	16
ORU's Program	53	32	7	1	1

Table 2

Comparison of Contribution of ORU Physical Education Program with other College Physical Education Programs (Percent)

	Very Significant Contribution	Moderately High Contribution	Average Contribution	Moderately Low Contribution	No Contribution
ORU	39	35	18	6	2
School A	11	23	38	17	11
School B	16	18	36	19	11

results from spring 1983 support two previous investigations. (See Table 3.)

Summary

We are now in the 10th year of the program. It has strong support from both administration and students. In repeated "in house" studies we observe our students significantly improving in fitness, knowledge, and attitude during their first year at ORU and that they maintain it for their remaining years at ORU. All indications are they continue the lifestyle upon graduation — the ultimate test of our program.

Table 3
Pre- and Posttest Changes as a Result of a Health Fitness I Course

Variable	Group	Mean T_1	Mean T_2	Diff	t	Level of Confidence
Body Fat (%)	Males	18.2	17.5	-.7	2.12	.05
	Females	27.3	26.8	-.5	1.34	NS
	Total	22.3	21.7	-.6	2.38	.05
Weight (lbs.)	Males	164	163	-1	1.51	NS
	Females	141	140	-1	1.24	NS
	Total	154	153	-1	2.06	.05
Field Test (min.)	Males	10.98	10.32	-.66	7.11	.01
	Females	11.64	10.90	-.74	4.01	.01
	Total	11.27	10.58	-.69	7.24	.01
Knowledge (%)	Total	42.7	70.0	+27.3	27.38	.01

Helping Adults to Stay Physically Fit

Preventing Relapse following Aerobic Exercise Training

G. Ken Goodrick
G. Harley Hartung
Don R. Warren
Jean A. Hoepfel

Long-term adherence to an aerobic exercise regimen is a major problem among exercise program graduates. It is estimated that over half of participants in exercise programs become nonadherers within 12 months.[1] For example, Lee, Owens and Innes[2] found that only 50% of persons graduating from a three-month training program adhered to aerobic exercise one year later. Two-year and three-year follow-up adherence rates were 30% and 5%, respectively.

There has been some recent work in promoting adherence to exercise while individuals are participating in programs. Franklin[3] discussed ways to enhance motivation using such techniques as bulletin boards, newsletters, group interaction, positive reinforcement, and games. Others[4,5] have used behavioral contracts to promote attendance and exercise during programs. Hall[6] proposed that behavioral self-management techniques could help exercisers resist environmental and emotional barriers to exercise. However, most participants do not continue in an exercise class indefinitely. The techniques which promote attendance and exercise *during* a training program may have no positive effect on *long-term* adherence after a participant leaves a program to exercise alone.

Recently, behavioral psychologists have developed "relapse prevention" treatment strategies for enhancing long-term adherence to recommended health behaviors.[7] These treatment strategies were developed analyzing the reported thoughts, feelings, and life situations associated with relapse. From such analyses, treatment programs have been designed to help patients recognize and overcome typical problems leading to relapse.

As a first step in developing relapse prevention strategies for aerobic exercise programs, we surveyed by mail 200 graduates of a hospital-sponsored adult fitness program. There were 77 respondents. Average age of these graduates was 43, and 70% were female. The survey, conducted between six and 12 months after respondents were graduated from the 8-week program, asked about current exercise habits, and about motivational and environmental barriers to regular exercise.

Using the aerobic criterion of exercising at least three times per week for at least 20 minutes each time, we categorized graduates as either adherers or nonadherers to aerobic fitness regimens. The categorization was definitive since all adherers were meeting or exceeding the criterion with an average frequency of 3.9 times per week, and a duration of 40 minutes, while nonadherers were averaging one exercise period per week with an average duration of 13 minutes. By this criterion, 40 (53%) were nonexercisers, and 37 (47%) were considered to be maintaining aerobic fitness. We were unable to obtain data on nonrespondents, but one can assume their rate of adherence was not better than for respondents, and probably worse.

The survey results revealed that adherers and nonadherers give quite different responses regarding their self-reported barriers to exercise. As shown in Table 1, there were large differences in the reasons graduates gave to explain reduced exercise. Most nonexercisers attributed their relapse to a lack of time, while exercisers were most likely to mention injury or illness. It is noteworthy that 61% of exercisers claimed to have no problems in maintaining exercise. Among nonexercisers, feelings of tiredness or lack of energy was the second most frequently cited reason for quitting. The "life stress" category included changes in job or marital status, or a change in residence. These findings suggest that relapse prevention treatment strategies should help participants deal with perceived time pressure, lack of energy, and stress.

Perceptions of time pressure could be dealt with using elements of time management training.[8] In this training, participants would learn that aerobics need take up only 5% of their waking hours. This 5% could include 3 hours of exercise and 2.5 hours of preparation and clean-up each week. Participants would learn how to assess their use of time using

Table 1. Reported Problems which Limited or Prevented Exercise

PROBLEM	NONEXERCISERS (n = 40)	EXERCISERS (n = 37)
Time pressure	56%*	6%
Felt tired, lacked energy	51%	20%
Injury or illness (unrelated to exercise)	27%	25%
Life stress	24%	3%
Weather	17%	8%
Dislike exercise	17%	0%
Need group support	15%	0%
No problems at all	0%	61%

*Percent of those responding

diaries, how to schedule and set priorities, how to discover the causes of exercise procrastination, and to think about what value they place on being physically fit relative to other uses of their time.

Perceptions of lack of energy as a barrier to exercise could be minimized by emphasizing that increased physical fitness is normally associated with increased perceptions of energy. To enhance feelings of increased energy and to avoid perceptions of overexertion, exercise intensity and duration should be self-regulated based on perceived exertion[9] or perceived changes in breathing.[10] Participants would learn that those with higher levels of fitness need to use a lower percentage of their total energy capacity to do the routine physical tasks of life, so that they feel less tired as a result of regular exercise. In addition, many people find moderate exercise to be invigorating even to those who feel tired at the start of the exercise period. Those who receive this training should be less likely to stop regular exercise because of perceptions of tiredness or lack of energy.

Some participants reported that their exercise stopped due to such life stress as divorce, changed job, or residence. Relapse prevention for these problems would consist of emphasizing the stress-reducing[11] and antidepressant[10] potential of regular exercise. Many nonadherers seem to think of exercise as a burden or stress-producing activity. Participants trained to think of exercise as an enjoyable, stress-reducing behavior should be less likely to stop exercising when life stressors arise.

Traditional exercise programs have emphasized how to exercise and what health benefits accrue. To maintain exercise habits, there is a need to focus on causes of relapse. Cognitive strategies using didactic techniques, for example, involve changing participants' beliefs about time needed for exercise, or the health benefits of exercise. Affective strategies using experiential techniques would emphasize the focus on the antidepressant and stress-reducing potential of exercise during guided exercise sessions.

Treatment programs should include a follow-up period of up to a year[12]. During this period participants would exercise on their own but would meet once a month in groups with a trainer/therapist to work on real and perceived barriers to exercise, solving problems on an individual basis.

The exercycle is new; the body on it—not so new. The condition of the former is excellent, and of the latter. . . . If exercisers blame "not enough time" on their lapses from fitness, fill in the missing television set in this picture (doing two things at once saves time!) and the missing relapse prevention training in the original exercise course.

Since the results reported in this study are subjective interpretations of each respondent's behavioral history, and since the return rate was low, others will need to discover the most important causes for relapse for their treatment programs and participant populations. Factors possibly contributory to the relapse process but not reported by participants would need to be investigated. These might include lack of social support, inconvenience of exercise facilities, unrealistic goals, or participant-program mismatch.[13]

It is clear that traditional, short-term exercise programs without relapse prevention training cannot be expected to achieve long-lasting exercise habits except among a very small percentage of participants. It remains to be seen whether longer-term programs with relapse prevention can do better. The authors hope that this report will give others a procedure for development of relapse prevention treatment strategies.

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A CORPORATE HEALTH AND FITNESS PROGRAM

MOTIVATION AND MANAGEMENT BY COMPUTERS

WILLIAM B. BAUN
MICHELE BAUN

Many health experts support the hypothesis that chronic negative lifestyles are the leading cause of illness today. Industries' acute awareness of this predicament has caused them to seek strategies to help preserve their most important asset, the employee. Approximately 50,000 American companies have developed health and fitness programs emphasizing the acquisition of self-care skills required to attain and maintain optimal health. These programs generally use a health promotion strategy which begins with employee awareness and understanding followed by instruction and practice in health fitness areas. Their central theme is expanding the employees' responsibility for total health. Critical to the success of the program is motivating employees to participate, thereby enabling them to improve and maintain their health.

Many exercise professionals would agree that adherence to an exercise program depends almost entirely on motivation. Motivation researchers have shown that positive feedback indicating achievement and progress through exercise participation provides a sense of satisfaction for participants. Feedback has become a critical challenge in these programs. With computers have come creative approaches for motivating participants.

Design and Development

Tenneco's health and fitness program uses a computer system to help achieve departmental goals and objectives.[1] Individuals, both inside and outside the company, worked together over a year to develop the system which was reviewed, then revised into a workable program by a task force of computer and health and fitness personnel. The task force ensured that the program was feasible to develop, produce, and maintain and that it would fully support the health and fitness staff's various needs. Important in the initial development were detailed descriptions of the various computer functions: (1) employee membership, (2) participant check-in and check-out, (3) fitness and medical testing, and (4) exercise logging.

These four main functions provide the framework on which the interacting program was based. Each function

was further broken down into specific programmatic needs. The employee membership function serves as the central axis for other functions. It ensures proper identification of participants and allows storage and retrieval of demographic and exercise data.

The participant initiates the check-in and check-out recording procedure, using a credit card-like employee badge with an identification number on a magnetic strip. As employees complete the health and fitness screening process, the badge is encoded so that they can be identified as a member of the health and fitness center. When employees enter the facility, they run the employee badge through the badge reader which then recognizes the individual as a member and records entrance and exit time. This data permits analysis by user frequency, duration of visits, and who uses the center.

The fitness and medical testing function serves as a record management system. Data collected from initial screenings and subsequent assessments are entered by health and fitness support personnel using department terminals. Using input screens similar to the collection forms makes entry fairly easy. Upon entry, portions of the raw data are automatically transformed into useable information (such as percent fat and percent lean) or into rating scales (21 curl-ups being assigned an average score for the abdominal curl-up test). This function serves several purposes, the most important being storage of testing data with easy accessibility and analysis.

The exercise logging function is unique to the system. It allows the participants to record their activity immediately following exercise through four input terminals conveniently located within the exercise area. Participants can log 19 different types of exercise activity, including many which cannot be performed within the downtown facility (see Table 1). Thus, exercise activities performed away from the main center are an important part of participants' records.

Each activity requires duration, intensity, and body weight to be entered before the computer can calculate caloric expenditure mathematically. The formulas for each of the 19 activities are the result of a technical report by Mike Pollock, Jack Wilmore, and Tony Jackson,[2] commissioned by Tenneco specifically for this system. *Duration* is the length of time the activity was performed while *intensity* is a function of *METS* (multiples of resting metabolic units). Every seven days the program requires the user to enter body weight which is saved and used for the next seven days of caloric calculations. The 19 different activities fall into five general equation categories which require different input to compute the intensity factor. The categories are (1) walking and running, (2) bench stepping, (3) stationary bike riding, (4) weight lifting, and (5) other modes of exercise requiring entry of a perceived exertion rating.

Crucial to the success of an exercise logging system is ease of entry. Many systems used in exercise environments are interactive: the program constantly asks questions. Unfortunately, an interacting format takes time, and in a busy exercise facility this could mean long lines at computer terminals. Tenneco's system was developed with both ease of entry and economy of time as important criteria. The system allows six activities to be entered upon the exercise logging screen. Before the system saves the data, participants can check for errors and change the data or location code. The majority of activities are recorded immediately

Table 1
Exercise Activity Offerings

• *Nautilus Weight Lifting*	Swimming
• *Jogging/Running*	Cycling
• *Walking*	Rope Jumping
Fitness Classes	Basketball
Racquetball	Skating (Roller or Ice)
Handball	Soccer
• *Stationary Bike*	Cross Country Skiing
Tennis	Badminton
Squash	• *Bench Step*
Golf (Walking)	

• Activities in italics do not require an intensity code. Intensity levels of (L) light exercise, (M) medium exercise, and (H) heavy exercise are necessary for all other activities.

At Tenneco's Health and Fitness Center, members log their activities following exercise and receive immediate feedback—information that is not only useful but is also motivational.

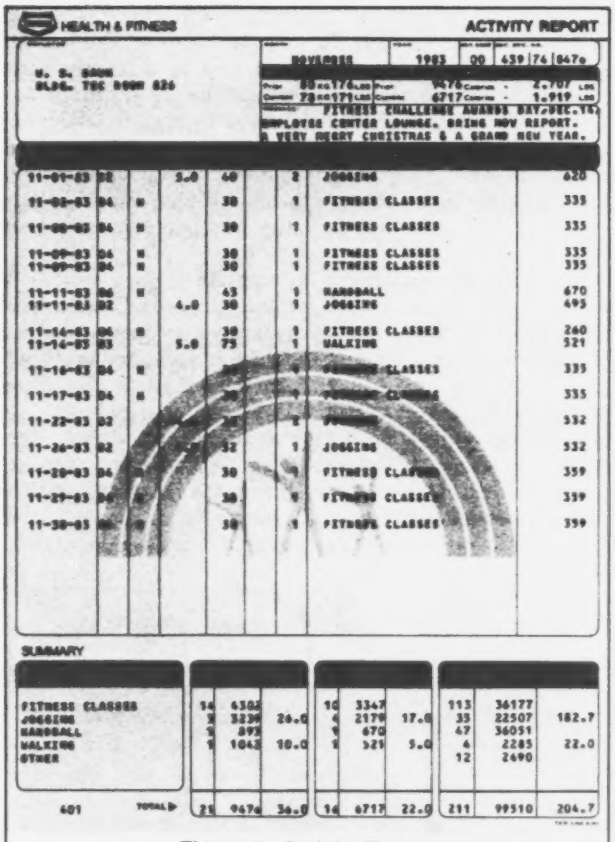

Figure 1. Activity Report

Staff member enters data on a staff computer terminal.

following exercise; however, participants can change the date and exercise location if they want to record exercise completed either outside the center or on a different day than the present date. The exercise logging code sheet is another logging option. This allows individuals to submit a written record of their exercise for the month which support personnel then enter.

Exercise logging generates immediate caloric feedback to the participant on the computer terminal. Participants receive monthly reports of accumulated exercise data in a written activity report. These data are also critical to the staff monthly reports, which monitor the effectiveness of the entire program. Therefore, the exercise logging function, estimated at over 17 million bytes a year, is the bulk of data entered, stored, and used within the system.

Feedback and Reports

As indicated above, the system produces feedback to participants and the health and fitness staff. The immediate caloric expenditure feedback received following exercise logging has generally elicited several different participant responses. When individuals begin to see the small number of calories they expend while exercising, they are better able to understand the importance of combining exercise with good eating habits. Others appear to monitor their daily caloric intake and expenditure regularly, altering their diet according to the number of exercise calories expended. Still other participants are more interested in mileage than in calories expended. These individuals use the system purely as an exercise diary or a training record. The system provides the staff flexibility in counseling and motivating individuals toward healthier lifestyles, allowing staff to deal with participants at all levels of exercise knowledge.

Although the immediate participant feedback is important, each exercising member's monthly activity report is probably most beneficial (see Figure 1). It provides a record of each activity entered each month, comparing the present to the prior month and giving an accumulation of calories, mileage, and exercise sessions for the year-to-date. This information serves several important purposes. It is motivational, giving those who have a successful program several pages of positive feedback. Many of these individuals place these reports in notebooks each month. Individuals with adherence problems receive a very short report reminding them of their exercise negligence. Since these reports are placed on microfiche and maintained on file, the staff can refer to specific reports in subsequent counseling.

Other feedback components help the staff to evaluate the program continuously. Monthly statistics, which generate data concerning various elements of the program, are used to compile a monthly report to senior management to provide a quick profile of the center's activities and adherence rates. These monthly statistics continuously record the center and its members, allowing for longitudinal analysis of the data base. Although not a major departmental objective, research has become a prime outcome from this elaborate monitoring system.

Motivating the Individual

The participant feedback mechanisms are not the only tools used to motivate individuals. The staff uses several other techniques independent of the computer to personalize program offerings.

Many individuals are drawn into fitness and remain active because of their competitiveness. Each month a listing of the top 75 calorie burners, runners, and walkers is posted to provide these individuals incentive for participation. Interdepartmental weight loss and mileage challenges offer special prizes or monetary rewards. Every three months the center holds a "Fitness Challenge" award program for individuals who exercise a specified number of days and burn an allotted amount of calories based upon their body weight. This gives every participant an opportunity to earn a t-shirt, gym bag, and other items which identify them as an active participant. The process is designed so that as a person exercises, more different items are received, but people who meet the minimum accepted exercise requirements (three times a week and approximately 300+ calories) are also recognized.

Monthly letters are sent to individuals who are becoming or who are nonparticipants. The initial no-show letter is sent to an individual who has not exercised for three months. This letter reviews the new activities and the coming events being held in the center. Following six months of nonparticipation, an individual is sent a letter reflecting the department's concern. After nine months of nonparticipation, the individual's locker is given to another participant and the individual is warned that membership is lost after 12 months of nonparticipation. The final letter invites the nonparticipant to review his/her exercise record with a fitness professional and to set new goals. This process depends on the computer system to supply labels for the different performance groups. Because the process has been tested only 18 months, its effectiveness is hard to measure. However, it appears to improve management of a large (3,600) participant population and to increase faithful participation.

Letters are sent to nonparticipants, and yearly birthday cards are sent to each member. The card not only extends best wishes for a happy birthday, but also reminds the member that it is time for a fitness retest. It also allows the staff to write short personal comments to individuals.

The tremendous sorting power of the system is further illustrated when flyers are sent to certain groups of the member population. Targeting a promotional campaign to specific age, sex, or activity participation groups has increased campaign effectiveness. The system saves time and money and allows staff members to personalize their approach.

The computer system has been under constant examination to make it a more effective tool for the exercise professional. Changes have already made the system user friendly, as this is the first and only direct contact with a computer for many of the participants. The staff listens closely to suggestions which make the system easier to use.

Expectations for use of the systems in other Tenneco exercise environments are high. Currently, the department manages two other small satellite exercise facilities, serving approximately 170 employees at each location. A project now underway will link these facilities to the main system, thus permitting collection and analysis of comparative data. Although not presently on line with the main computer, these satellites use the exercise logging function by submitting the exercise record encoding sheets each month.

Corporate health and fitness programs will continue to multiply and grow in response to higher medical costs. The use of the computer in these programs will expand in response to corporations' need to evalute program effectiveness. Evaluation can only be accomplished through the use of a sophisticated computer system. The data bases now being collected and analyzed are providing justification for health and fitness programs. However, the main reason for using a computer in a corporate exercise environment will remain its tremendous potential as a motivational tool and its ability to create employee awareness of the benefits of positive lifestyles.

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QUESTIONS TO THINK ABOUT WHEN INTRODUCING A COMPUTER SYSTEM

- What new information does this system give me?
- What is the value of that information?
- Who will use the information?
- What has the experience of peers been in similar experiences?
- What is the full cost of implementation, such as software, periphery devices, insurance, training, and maintenance?
- Who are other potential users who could share costs and resources?
- Is there another way to produce the same results?

—The Editor

Photo courtesy of Institute for Aerobics Research

Physical Fitness

Programming Issues for Total Well Being

Kenneth H. Cooper Thomas R. Collingwood

Corporate fitness and health promotion programs have experienced an exponential increase during the last decade. The popularity of these programs comes from the emerging public consciousness of the value of preventive medicine. As professionals, we need to realize that employee worksite programs are no different from any other programs—they can either be beneficial or detrimental.

An estimated $5-7 billion is spent on corporate fitness each year, capital outlay forcing decision-makers to look at the cost-effectiveness for all health promotion programs. While research has been limited, available data indicates that actual employee behavior change and compliance *may* or *may not* occur.[1] Consequently, the effectiveness of programs must be studied.

During the last several years, the staff of the Aerobics Center's Institute for Aerobics Research has been developing, delivering, and evaluating employee fitness and health promotion programs within the private and government sectors. In reviewing these efforts, we have attempted to determine the factors most critical to program accountability, defined as compliance to changing behavior and achieving goals.

First and foremost, we must address the human element—the target population. Secondly, program models and program elements—especially education—need to be applied systematically. Finally, we must obtain organizational commitment if a program is to get off the ground and succeed.

Human Factors

From the perspective of preventive medicine we feel the major justification for a fitness or wellness program is reducing disease risk and containing costs. However, when asked why they exercise, participants often answer, "It makes me feel good." The human element must never be forgotten.

Accountability is the major issue in program implementation. Accountability means building a program which facilitates adherence. In reviewing a variety of employee fitness programs and in validating our own efforts with patients and organizations, several success symptoms emerge relative to the "human factor"—participant compliance to a program.

1. *Administrative support* is present and is communicated to participants. Top management are involved with policy designed to operate the program. Top management provides leadership, often by first getting them involved in their own program.
2. A *long term* commitment is based upon the realization that results take time. Faith and the realization that an investment in human resources is necessary over a period of time.
3. *Programs are convenient,* schedules and facility use are arranged to be convenient for participants.
4. *A goal orientation* directs participants' effort. Reasonable goals are individualized to maintain commitment.
5. Programs are *safe and progressive* to avoid injury and to maintain enthusiasm.
6. Adequate *supervision* ensures safe and effective programs, providing the "human" element in programming.
7. Programs are *personalized,* especially for sedentary adults, to take individual preferences and needs into account.
8. *Education* is associated with activity in which persons participate.
9. *Motivation* is not left to chance, but is planned systematically.
10. Both formal (such as a reporting system) and informal measurement and evaluation are employed to ensure *feedback.*
11. *Social involvement* is emphasized through spouse, family, and peer programming.
12. Programming is *fun,* all program elements have a positive emphasis.
13. Using skilled *role models* as leaders makes use of identification and modeling—critical motivational tools.

Program Models

There are many fitness and wellness models. Some are narrow in focus such as hypertension screening programs, while others attempt to provide a broad service program which affects physical, emotional, and spiritual well being. Successful programs recognize the importance of specific results that lead to positive behavior change and their generalization to other areas.

As an example, the Aerobics Program for Total Well Being is delivered to patients and employee groups alike as a comprehensive approach to lifestyle change. We feel that fitness and exercise is the base for expanded behavior change. People on an exercise program for the first time acquire internal control and an active (as opposed to passive) orientation towards changing their lifestyle.

For example, changes in dietary, smoking, and stress control can more readily proceed after one has developed a fitness base. Longitudinal and cross-sectional research at the Aerobics Center indicates that fitness level (as measured by treadmill times) is a highly significant predictor of coronary risk and disease.[2] In many respects, fitness level can be viewed as an index of total lifestyle, in that the physically fit person obviously gets enough exercise, tends to eat more prudently, and usually doesn't smoke. Consequently, to control program success, fitness needs to be the base and starting point.

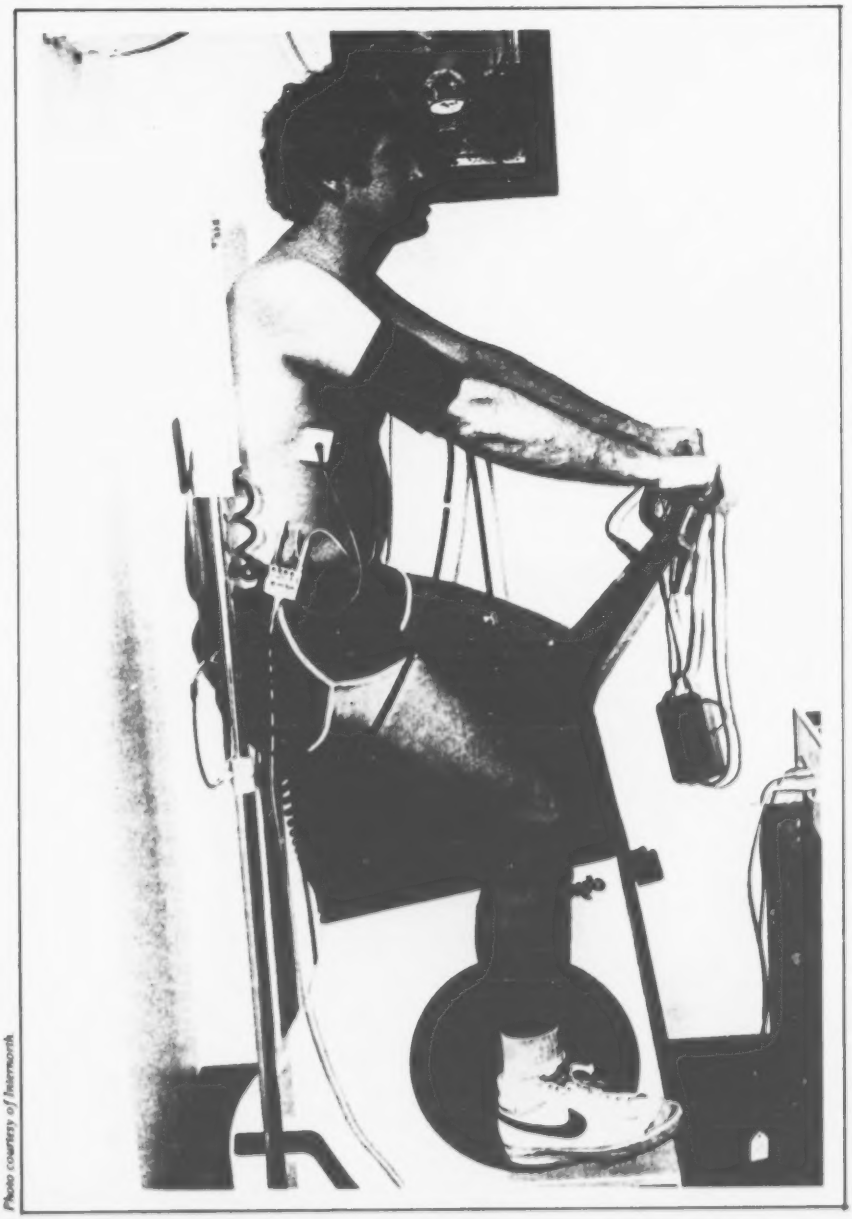

Photo courtesy of Intermonk

Program Elements

Because of diverse program services provided, a conceptual view of program elements is not always easy. Some programs emphasize screening and assessment while others provide only a facility or exercise classes. Whether a person is acquiring an exercise habit or an eating habit, that person must first view where he/she currently is, define where he/she needs to be, and have the means to move to the goal.

To maximize fitness and behavior change gains and to facilitate adherence, the Institute for Aerobics Research is validating an eight element process. The elements are viewed as generic services for any program.

The eight elements include (1) medical screening to ensure safe exercise risks, (2) fitness and lifestyle assessment, (3) individual goal setting, (4) exercise and nutrition prescription, (5) supervised group starter activity programs, (6) educational classes, (7) a structured motivation and reinforcement system, (8) an ongoing feedback system. These eight services systematically attempt to focus and control behavior change and represent critical components of any successful program, encompassing the 13 success factors mentioned previously.

The rationale for these elements becomes apparent when we look at the four most important program evaluation questions: (1) Did we get the program to the right population? (2) Did we change behavior? (3) Did we change behavior over time? and (4) Did we obtain a cost benefit?

The screening and assessment elements aid in targeting individuals who really need a program. The goal setting and prescription process focuses on a behavior change plan. The group activity program motivates beginning participants to get involved. Structured education, reinforcement, and feedback sustain compliance to behavior change over time.

If a program does not reach individuals who need health and fitness behavior change or if the health behavior habits are not altered over time, the cost benefit will not be realized. In designing the program elements it is important to account for these factors.

Importance of Education

Education, a critical component of programming, deserves special attention. Some health education is a major element in most fitness and wellness programs, yet it has not always been effective. We have found that education can be effective if (1) it focuses upon health and fitness maintenance *skills* rather than just concepts, (2) if the participant practices skills integrated with exercise and activity, not only lectures, and (3) it is delivered by effective and credible leaders.

The Institute for Aerobics Research has been delivering a comprehensive fitness program to a large public school teacher population. Data analysis indicated a "chain effect" in which educational gains demonstrated a predictive validity for other gains.[3] Increased fitness knowledge was associated with positive changes in attitude and self-esteem, stress management, and an approximate reduction of absenteeism of 35% over the school year.

Supported by school tax revenues the program has been delivered to over 4,000 public school teachers. The eight previously mentioned elements are applied systematically with an educational focus. The participants then practice the exercise and nutrition prescription they have learned.

Obtaining Organizational Commitment

On the surface, cost benefit is the major selling point for corporate or government investment in a employee fitness or wellness program. Reduction of health care claims, insurance premiums, and absenteeism are all valid justifications for a program. However, other factors can motivate organizational commitment.

A recent Institute for Aerobics Research survey found that the public relations benefit of an employee program was the major reason several large corporations started their programs. It was also found that the individual commitment of top managers to personal fitness was also a major driving force.

Our experience has shown that several individual reasons may account for an organization's getting involved. It is important to be flexible and to get input defining a fitness/wellness program in an organizations' frame of reference. Starting with a pilot program for top management can aid in obtaining the personal commitment that is so important.

The concept of providing a larger pilot program also has merit. Delivering such a program asks an organization to "buy" proven, not an unproven process. The pilot implementation becomes the marketing vehicle, reinforcing the importance of providing an effective and accountable program.

Conclusions

The bottom line for a program should be accountability in terms of the human benefit (increased health, self-esteem) leading to a cost benefit (reduced absenteeism cost containment). In viewing the sources of variance for success or failure in the effort, we can interpret them as: 50% leadership, 40% program (including facility), and 10% organization.

The concept of a skilled role model with a valid systematic program in a supportive organizational environment must emphasize the leadership. Having a company gym but without a structured program and competent leadership will not accomplish the goals an organization is striving for. Health promotion is about people changing behavior. Most participants will not go through what must be done to change behavior unless there is a skilled leader who practices what he/she teaches. Leadership allows all the other things to happen.

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Incorporation of Aerobic Exercise into Health Maintenance Programs of Business and Industry

Dennis Colacino

The beginning and the organization of a corporate fitness program differs slightly from the beginning and organization of a university program or private commercial fitness program. Existing corporate fitness programs tend to be those of large multinational companies reflecting a major segment of the Fortune 500. Exxon, Pepsico, Texaco, Boeing, Xerox, Prudential, Chase Manhattan, and Ford are a few of these companies. Their programs vary in objectives and size. Basically they fall into two categories, medical or recreational; or a combination of the two types. Within this structure, eligibility for entrance into a program is based either on position grade/salary status (mainly executive programs) or, a program open to all employees. Many companies delineate this structure further into separate fitness programs: executive and employee. These fitness programs can be operated as company and in-house fitness programs where the facilities for exercise and changing are located within the company's physical plant or as an "out-of-house" program in which the facility is located in a YMCA or private health club. The latter type of program usually "contracts" with the company rather than the individual. In-house programs are either totally supported by the company or a nominal fee is charged from the participant's monthly check. The out-of-house program usually charges a flat corporate membership fee with slightly reduced rates when bought in multiples.

How have programs come into existence, and why the sudden growth? It would be nice if all programs were initiated because of health reasons but this, in most instances, is not the case. Some other reasons are: as a status symbol, or simply that the architect in designing a new building decided to put in an exercise facility, or a major competitor has one and therefore we'd better have one. Whatever the initial reason, be it a status symbol or a program on an experimental pilot basis, in most cases, after the program has developed the initial underlying philosophy no longer prevails. The now prevailing conviction is based on strong physiological data, medical benefits, and supportive psychological feelings. At this point, I would like to emphasize the dire need for good research on corporate fitness programs: program participation, fitness improvement, life-style modification, and cost effectiveness of the various fitness programs. Probably the common justification given for fitness programs is that physical fitness programs will increase work productivity and reduce absenteeism. This is a worthy goal, but it is my belief that a fitness program should go beyond that justification and try to change cultural norms. Norms are those behaviors expected, accepted, and supported by a group of people. This can be any type of group, but the people within any particular group will establish certain behaviors which will have a profound effect on the way we live our lives.

For example, the style of hair, the width of a lapel, or where we sit at dinner. These norms are not particularly bad or very important to us, but the norms that I wish to focus upon today are the negative cultural norms. Some of these norms can be a matter of life or death. For example, drinking while driving, eating a 2,000 calorie business lunch every day, the need to take a vacation, and the workload and stress build-up at the office. How common are these pervasive negative norms, such as alcohol, drugs, obesity, motor accidents, safety, stress, smoking, nutrition, and inactivity, all of which are spawned by our society? The research of Robert Allen, Morristown, New Jersey, searches for the answers. When employees were asked whether these above-mentioned negative norms existed in their environment, 75 percent of the negative norms were checked by the respondents as existing. If there is a high instance of negative norms in our culture, what are the perceived differences in our present health culture? In other words, if you ask someone, what is the company doing about health norms and what should they be doing, the results would indicate a large norm gap of approximately 40 percent. Furthermore, when asked what is the perceived company support for good health habits, 80 percent of the respondents noted very poor or not enough support for a cultural change. Therefore it is on this framework that present fitness programs should be based to help participants cope with pervasive negative norms and the means to reach self-achievement life-style changes.

How to implement a fitness program

I think it is germane to understand the hierarchy of a corporate setting. The model presented represents this format.

Chief Executive Officer (CEO)
President
Senior Vice-president(s)
Vice-president(s)
General Manager(s)
Manager(s) of Department(s)
(Personnel and Corporate Service)
Medical Division
Corporate Fitness Program

In most instances, the corporate fitness program is under the auspices of the Vice-president of Personnel or Corporate

Dennis Colacino is employed with Pepsico, Inc.

Services in which the medical department is housed. It is within this department that most fitness programs operate. But regardless of the exact chain of command, the schema is a long, complex, hierarchical system usually resulting in a slow, tedious pathway by which to implement change. Having a highly ranked proponent of fitness can hasten the process.

Purposes and Beliefs

Listed below are some of the major purposes and beliefs that I believe should exist in corporate fitness programs:

- A company sponsored fitness program should be conducted as an adjunct to the company's medical program.
- Consideration should be given to programs of physical training, rehabilitation, and self-achieving life-style.
- Physical fitness programs should be conducted on company time if at all possible, or within a flex-time work schedule.
- Participants should not be placed in competition with one another in terms of efforts expended, goals obtained, or strength increased. It is more of a life-style change rather than peaking to run the New York or Boston Marathon. Running a marathon may be a carry-over resultant goal of a program, but it is not the primary aim of a corporate fitness program.
- All programs should be supportive, educational, and motivational, with an established feedback system to help each individual understand the exercise regime, stress-testing results, and behavioral modification techniques.

Administration

Each agency (government, university, or private) once having established a set of purposes and objectives can implement them into a functional operating program. The underlying code of operation is based on the allocated space, time commitment, cash outlay, and, unique to fitness programs, legal ramifications. When these are resolved, then operational procedures proceed on a day-to-day schedule. These include:

- Definite hours of operation for the facility should be established. If you do not establish strong guidelines, participants will abuse the hours.
- Participants should receive a specific training program coordinated to meet corporate policy, and in conjunction with the company's medical policy and the individual's best interest.
- There should be a method for tracking compliance/adherence of participation. Research from Canada indicates the most important form of motivation for adherence to a fitness program was the "retest." When combined with some form of educational feedback, the adherence rate was markedly strengthened. Surprisingly, T-shirts ranked below retesting and educational feedback as a motivational technique for compliance/adherence to a fitness program.
- There must be an establishment of strict safety rules in regards to use of equipment and strict enforcement of "exercise" training policies.
- One should observe and comply with federal regulations, such as OSHA (Occupational Safety and Health Act) concerning exposed chains or moving belts and electrical safety codes.
- Dress codes should be established. Within most corporations there is a logo, which can represent a feeling of belonging.

Research and evaluation should be conducted to determine the effect of the program and if stated objectives have been met.

Medical Provisions

- All candidates should obtain medical clearance for physical activity.
- Medical emergency procedures should be established. Emergency buttons should be placed in the appropriate locations within the exercise area and locker room. The stress testing room, as well as the exercise area, should have a defibrillator, oxygen, and drug cart available. The staff should be CPR trained. An operational plan should be devised and procedures practiced.
- Results of the participant's progress in the corporate fitness program should be sent to the medical staff on a periodic schedule and also to the participant's own private physician, upon request.

Prevention of Orthopedic Injuries Related to Aerobic (Jogging) Exercise

David Cundiff

In 1977, a Gallup poll asked Americans whether they participated in daily, nonwork-oriented physical activity designed to keep them physically fit and if they did, whether that daily activity included jogging. In 1961, when the same questions were asked, only 24 percent of the sample replied affirmatively. In 1977 a surprising 47 percent gave a positive reply with almost no difference existing in the numbers of males (50 percent) and females (45 percent). Twenty-four percent of those who worked out daily were joggers, which was a projected 11 percent of all Americans and 74 percent of those joggers covered at least 1 mile a day.

The jogger or long-slow distance runner (LSD) who covers 30 miles/week plants each foot more than 1 million times a year. Fear of jogging injuries is becoming a major obstacle in convincing lay persons to start exercise programs and causes a high dropout rate in some programs. These stress-induced injuries are signaled by the onset of localized pain. In a study of the incidence of running injuries in 456 long-distance runners, the following percentages were reported:

Calf 9%
Hamstring 9%
Achilles 18%
Heel 14%
Arch 15%
Hip 11%
Knee 35%
Shin 19%
Ankle 23%
Forefoot 22%

Eighty-three percent of the runners claimed one or more of these injuries.

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Many joggers and LSD runners jeopardize their well-being by failing to recognize the basic mechanical causes of jogging injuries. The normal mechanics of distance running can be summarized by the term "heel-toe." The support phase of the typical jogging gait is divided into the following support phase mechanics:

1. *Heel strike*
   supination
   Impact bearing
2. *Mid-stance*
   pronation
   stress dissipation
3. *Toe off*
   supination impact
   lever lifting

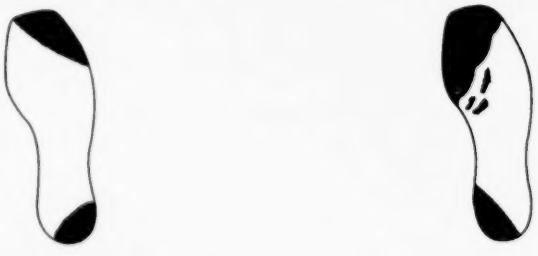
This typical gait will lead to the shoe-wear patterns depicted in Figure 1.

The proper approach to the prevention and/or management of jogging injuries must include attention to the following considerations: determine whether there are structural foot and leg weaknesses, muscle imbalances, or lack of flexibility and the overuse syndrome.

Any abnormal foot plant or excessive leg rotation in the support phase may cause localized foot, leg, knee, or hip stress. Examples of improper support-phase mechanics are: femoral anteversion with external tibial rotation, and flat feet or forward varus (extreme pronation). Correction for faulty weight distribution and reduction of excessive rotational stress on the knee and hip can be done in two ways. *Shoe control* — adequate heel width prevents hyperpronation and snugly tied shoes will control heel movement at heel strike. *Orthotic control* — a soft insert can be used to support mild foot plant derangement or a rigid orthosis with rear foot or forefoot post provides the best control of severe pronation or supination weaknesses. An attempt should be made to have a foot plant so that the big toe is inside the knee.

Muscle Imbalance and Lack of Flexibility

The posture of our sedentary lives leads to shortening of certain muscle groups such as the hamstrings. Muscle tightening and shortening in the resting state is a common response to running stress and leads to muscle imbalance. Running overstrengthens the antigravity muscles (psoas, hamstring, and calf),



Normal Wear (right foot)

Abnormal Wear (right foot) (caused by excessive pronation)

Figure 1. Normal and abnormal shoe wear

resulting in increased tension and work in the opposing muscle group (quadriceps, abdominal, and anterior tibialis). Corrective exercises involve stretching the strong, tight group as demonstrated in Figures 2–4.

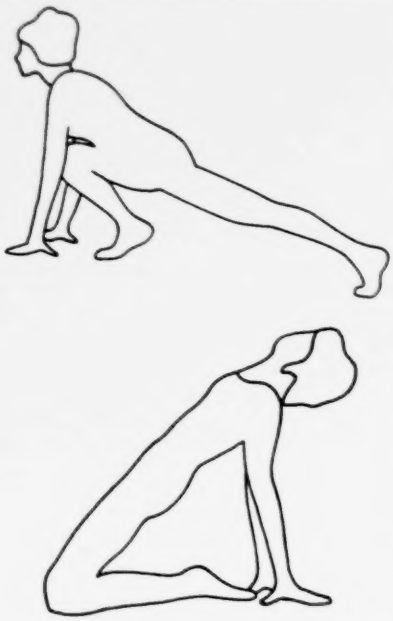


Figure 2. Stretching iliopsoas and quadricep muscles.

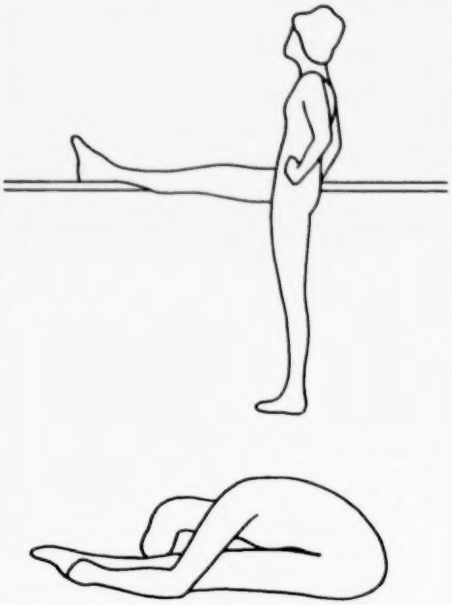


Figure 3. Stretching hamstring muscles.

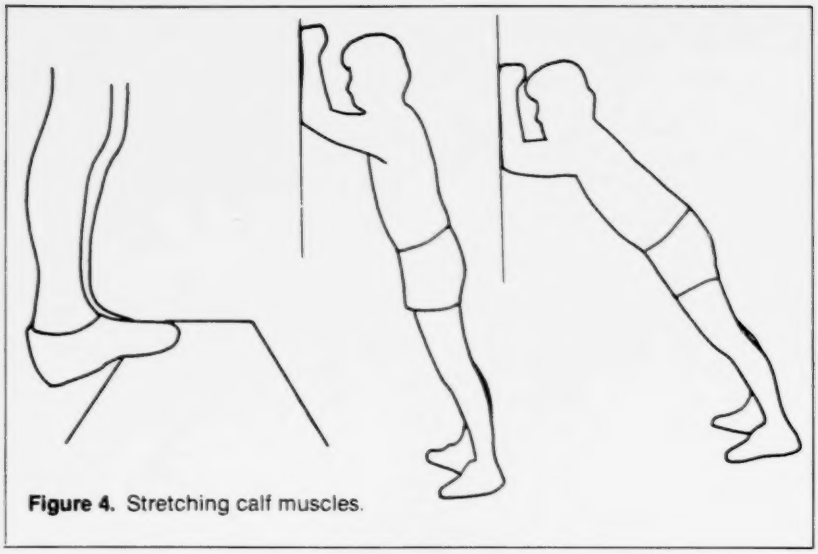


Figure 4. Stretching calf muscles.

Corrective exercises involve strengthening the weak, overworked muscle groups as illustrated in Figures 5-8.

Overuse Syndrome

When biomechanical weaknesses are

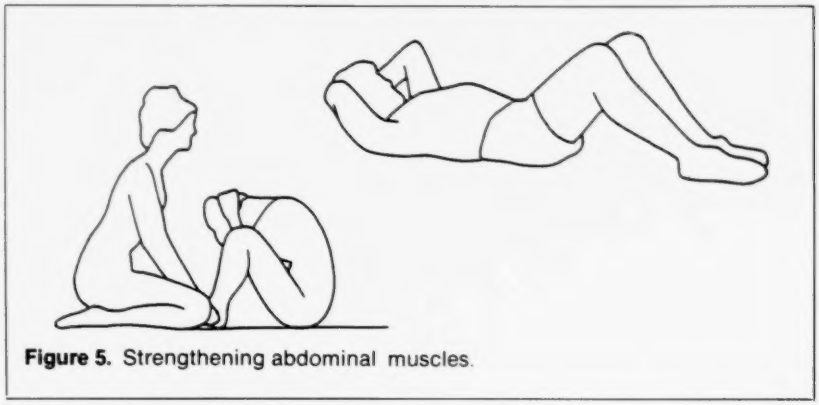


Figure 5. Strengthening abdominal muscles.

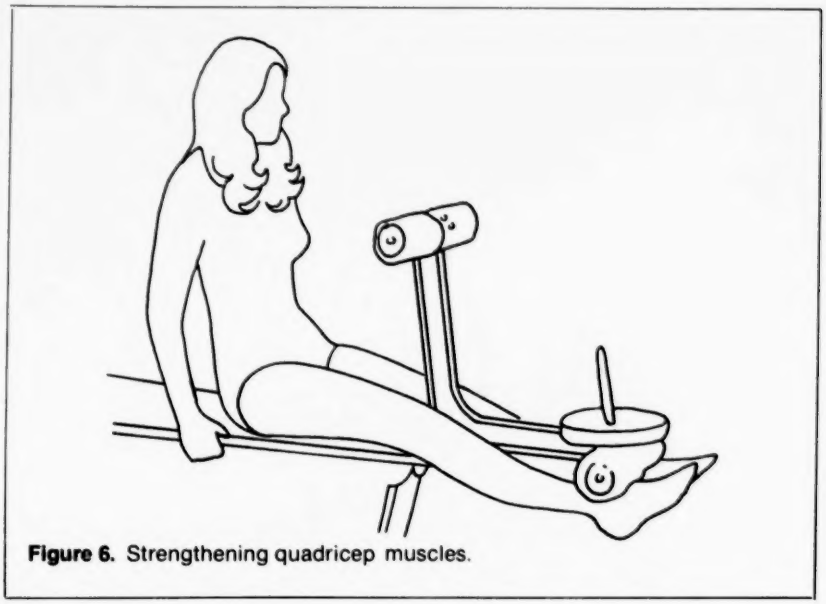


Figure 6. Strengthening quadricep muscles.

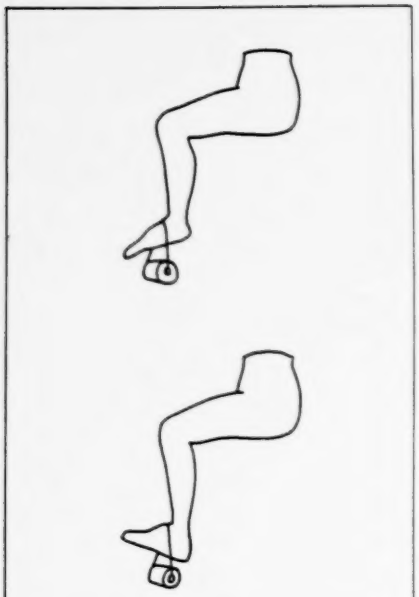


Figure 7. Strengthening anterior tibialis muscles.

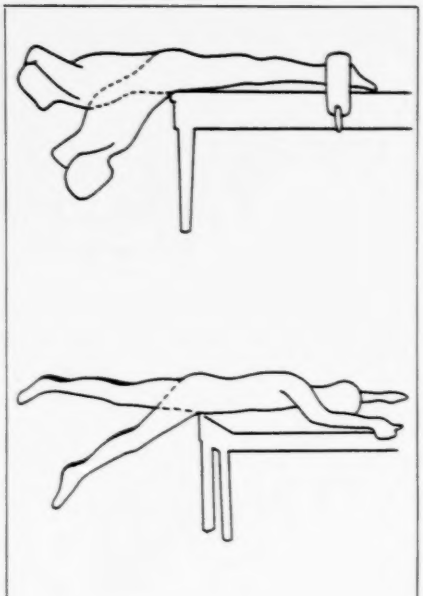


Figure 8. Strengthening erector spinae muscles.

present and one adds the excess stress of hard workouts, insufficient recovery periods and/or improper approaches to training, a breakdown can be manifested through localized pain and general fatigue. Gettman, Pollock, et al. (1977) found that leg-muscle soreness and shin splints were more prevalent in joggers who trained in a 5-day-per-week group compared to 3- and 1-day groups. The leg soreness was chronic throughout the 20-week program for 6 of 13 persons in the 5-day group. The 5-day group produced the greatest improvements in cardiovascular function and body composition but they did not recommend a program of 5-day-per-week for beginning joggers. To avoid the effects of overuse syndrome, the body warning symptoms should be heeded by 1) resting until localized pain subsides, and 2) modifying training routine.

Summary

1. The prevention and/or successful management of jogging injuries depends on the analysis of the static and dynamic aspects of the jogger's gait.
2. Treatment of the basic underlying muscle imbalance or structural weakness will improve or prevent most problems.
3. Shoe modifications can balance the foot and control rotational stress at the knee and hip. The even distribution of force in the mid-stance phase reduces foot strain.
4. Surgery or local injection should be used with caution. Response to brief rest and anti-inflammatory medication should be monitored and training patterns and/or shoe style should be altered.
5. No medical treatment can produce instant healing.
6. An ounce of prevention is the key.

Reference

Gettman, L., Pollock, M., et al. 1977. Physiological responses of men to 1, 3, and 5-day per week training program. *The Research Quarterly*, 47 (4):638-646.

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